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ELECTRICAL REVIEW

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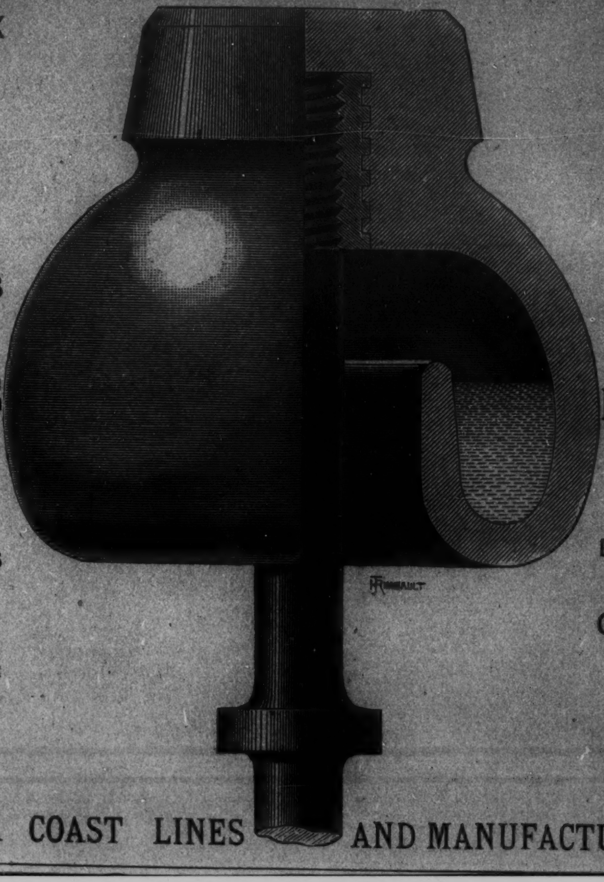

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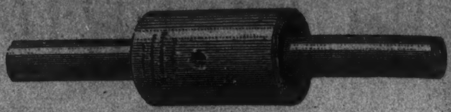

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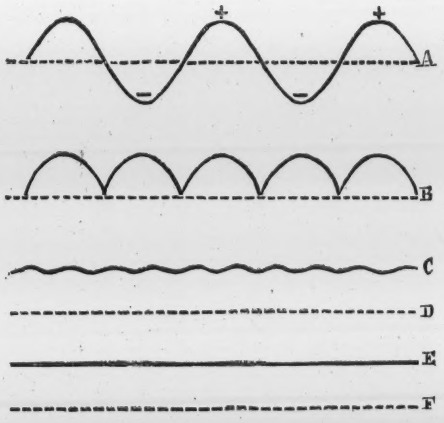
THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVI.—NO. 377.

TELEPHONIC CIRCUITS.

AT the present time comparatively little attention is paid by electrical engineers or scientists to telephonic matters, although there is much that is interesting in the subject. Although we hear from time to time rumours of warfare and threats of litigation between telephone companies, or between a company and individuals, yet the rumours do not form themselves into tangible shapes. The discussions and correspondence which are occasionally carried on with reference to the validity of certain patent claims and the correctness of certain theories, if not logically conclusive are at least of interest as bringing us a little nearer to a precise comprehension of the action of the telephone. The main point at issue is that concerning the possibility of producing articulate speech by transmitters working on the make-and-break principle. We ourselves are very far from being convinced that make-and-break working is possible, *i.e.*, that articulate speech can be *produced* by a make-and-break action, that it can be produced *in spite of* such an action is quite probable. We have not yet seen one single experiment which has in the slightest degree proved that articulate speech can be *produced* by the action referred to. The fact that words were heard with a Reis transmitter is no proof whatever upon the point, as it is quite probable that the instrument is capable of causing a variation of resistance at the points of contact, though with no degree of certainty. Recently our verbose correspondent Major W. C. Barney has attempted to prove experimentally that an undulatory current through a closed circuit is not necessary for telephonic transmission, and he claims that the experiment of causing a rapid series of interruptions in the *transmitter* circuit which did not prevent good articulation, was a proof of this statement. We must confess that we entirely fail to see the force of the argument. It is not clear, in the first place, why the interruptions should be chosen to take place in the transmitter rather than in the receiver circuit, seeing that it is Bell's and not Edison's claims that are being attacked; leaving this question aside, however, it seems to us that the correctness of his argument must stand or fall by a consideration of what is *technically* meant by a "closed" circuit. The technical meaning of "closed" and "open" circuit working in telegraphy is, we believe, well understood; by a closed circuit we certainly do not mean a circuit which is never under any conditions open at all, nor on the other hand does an open circuit mean one which is never closed. It would be generally admitted, we think, that a momentary interruption, once, say, every minute, on a telephonic circuit would not produce any effect on the articulation, nor would these momentary interruptions be considered, we presume, to cause the circuit no longer to be considered as a closed one. If we admit that such is the case for momentary interruptions once a minute, we ought, logically, to admit it for momentary interruptions once in, say, every hundredth of a second. The argument which seems to be advanced, that an intermittent current cannot be an undulatory one is decidedly weak. In the case of a permanently closed circuit we have undulations passing which may be represented by a *continued* sinuous line; when the interruptions take place this line becomes a dotted one, but it is none the less a sinuous one, that is of an undulatory form. The word undulatory does not, we contend, necessarily imply continuity. With reference again to the term "closed," its obvious technical meaning is, we take it, a circuit which is closed at *some* period or periods of the time during which it is in use. It is, we believe, a generally well known fact, that the interposition of a "condenser" in the receiving portion of a telephonic circuit does not prevent the apparatus from working; indeed, except under certain conditions, it produces no appreciable effect, that is to say, the articulation is quite as loud and clear as it is when the condenser is not used. Such a circuit can hardly be considered a closed one within the general meaning of the term, yet it seems that no one has brought forward this fact as an argument against the soundness of the Bell claims. The action of the telephone may or may not be explainable on the undulatory theory, but we must hold that it requires experiments of a very different character to those hitherto described to prove the actual facts of the case.

DYNAMO-ELECTRIC MACHINERY.

ON the 16th September, 1884, Prof. George Forbes delivered a lecture on dynamo-electric machinery at the International Electrical Exhibition of the Franklin Institute in Philadelphia.



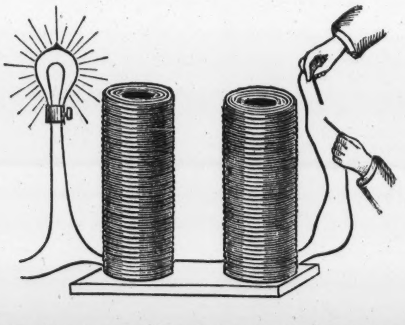
Action of Commutator.

A Alternate current—no commutator.
B Intermittent current—single commutator.
C Direct current.
D Double commutator.
E Continuous current.
F Multiple commutator.

In speaking of commutators the lecturer said:—"I have put up here a small diagram to illustrate the action of these commutators (see figure). In the old alternate current machine there is a bobbin passing the poles of the magnet; the current increases to a maximum and falls to a minimum, then increases to a maximum in the opposite direction when there is no commutator employed. When we put in a single commutator so as to reverse the current in each pole it rises to a maximum and falls to a minimum and we get this interrupted current, but always in the same direction. That was the first kind of continuous current made. Some machines were introduced to give a double commutation, that is, twice commutated in the course of a revolution, and thus an irregular sort of current was produced; but when Gramme introduced his machine with a vast number of commutations in one revolution he had a vast number of currents, and thus there is an almost continuous current produced by the Gramme machine."

Professor Forbes, during the reading of his paper, performed an experiment which is specially interesting from the bearing it has upon the performance of the so-called secondary generators or transformers of electrical energy. In alluding to the action of alternating current machines, the lecturer remarked that time would not allow him to deal with the subject, and therefore he would show but one remarkable experiment by means of an alternate current passed through a coil of wire on one arm of an electro-magnet and through an incandescent lamp.

Said Mr. Forbes:—"I will show these effects, because they are very remarkable. The effects of the alternate current machines are very difficult to understand at first sight. Perhaps, if I explain to you this one action I may have given some information to some of my audience here, and it may enable them to see some of the difficulties to be met with in alternate current machines, and enable them to avoid making mistakes in their applications in the future. I will pass an alternate current through one coil of the electro-magnet, and also through one incandescent lamp. That lamp glows very feebly indeed. But as soon as I join the terminals of this wire, going round the second coil of the electro-magnet, it immediately glows brightly (see figure).



An alternate current passing through one arm of an electro-magnet and an incandescent lamp. When the ends of the other coil are separated the lamp is dull; when joined the lamp is bright.

"When I have an alternate current passing through this first core, it is exercising a large power in magnetising and demagnetising that core. That core exercises its influence upon the other core to magnetise and demagnetise it. Thus the iron in these two arms of the magnet is being magnetised and demagnetised with great rapidity, and it is taking away from the current which is feeding this lamp. But as soon as I connect the wires of this other coil I am using up the power and magnetism in this core. I am making it do work in creating currents in this second coil; that is to say, this second coil acts as a drag on the magnetism of the core. So soon, then, as I connect the ends of the wire of this second coil the magnetism cannot change there so suddenly, and the primary current is not able to do so much work in the magnet, and therefore it is more free to exert its own force, and therefore it enables the lamp to glow with greater brightness than it did before."

THE DANGERS OF MECHANICAL GENERATORS OF ELECTRICITY.

By M. A. D'ARSONVAL.

THE more and more general use of powerful electro-magnetic generators has caused several accidents, some of them involving the loss of human life. It is therefore desired at present to regulate the employment of electricity and to determine experimentally the tension and the intensity which are dangerous in practice.

The problem thus set forth is not well put and is not susceptible of any solution, as the object of the present communication is to show. In the first place it is not, generally, when the electric current is permanently established that accidents take place, but at the moment of the establishment or of the rupture of the electric circuit. Under these circumstances the body of the experimentalist re-establishes for a longer or shorter time the continuity of the broken circuit. It is easy to show that at this moment the danger incurred depends by no means on the tension and the intensity of the primitive current, as is generally believed, but depends on quite a different factor, which cannot be calculated from a mere knowledge of the tension and the intensity of this primitive current.

All physiologists know that the energy of an electric excitement depends much less on the intensity of the current than on the rapidity of the fall of the potential and on the frequency of the shocks.

This being established, the following propositions become, so to speak, self evident:—

Proposition I. A battery and a machine producing in a rectilineal circuit two currents having the same intensity and the same tension, do not present the same dangers.

In fact, if we break the circuit in any point whatever, holding in each hand an end of the uninsulated wire, we find that the battery gives scarcely a shock, whilst the machine produces a much more considerable excitement of the nervous and muscular systems, an excitement which in certain cases may become instantaneously fatal. The reason of this difference is that the battery in a rectilineal circuit does not give an extra current, whilst the machine, by the mere fact of its construction, gives one, the power of which varies with the length and the manner of coiling of its circuit, as well as with the quantity of iron which forms its framework. The danger, therefore, resides simply in the power of the extra current resulting from the self-induction of the generator.

From these very simple considerations, the results of experience, we deduce the following propositions:—

Proposition II. Two machines yielding currents of the same intensity and the same tension in a similar circuit may be unequally dangerous, since their coefficients of self-induction and consequently their extra currents, may be very different.

Proposition III. A current not dangerous in one circuit may be dangerous in another. It is merely necessary to give the circuit a self-induction by any means whatever, *e.g.*, by the interposition of an electro-magnet.

I have verified experimentally these theoretical deductions by operating upon Guinea-pigs with a Gramme machine (laboratory model) and with accumulators. The tension of the currents employed varied only from 2 to 20 volts, and the intensity from 1 to 30 ampères. Notwithstanding the feebleness of the currents employed, the Guinea-pigs were nevertheless killed. We see, therefore, that if we wish to suppress all danger in the use of electricity, we arrive at the absurd conclusion that electricity itself must be suppressed.

I have sought for a remedy for this state of things. This is the method which has proved efficacious in all cases and which constitutes a general procedure for the suppression of extra currents.

To avoid all danger what, in short, must be done? Simply prevent the extra current from traversing the body of the experimentalist. We know that the tension of the extra current is infinitely greater than that of the primitive current from which it takes its rise.

This being admitted, I place in derivation at the extremities of the electric generator a series of voltameters with lead plates and acidulated water in such a number that their electromotive force of polarisation may be superior to the maximum electromotive force of the machine. This derivation is absolutely impassible by the direct current, whilst the extra current traverses it readily. At the moment when the circuit is broken the extra current passes through the voltameters and the human body is absolutely secure.

This is a general and very simple method for the suppression of extra currents. It admits of numerous applications, some of which I have already carried out, but their explanation cannot be given in this brief notice. I take voltameters with leaden plates because they develop practically the greatest electromotive force, and I vary the arrangement according to circumstances.

We see that the process which I propose consists in the establishment of a derivation, insurmountable for the direct current, and consequently occasioning no waste of current. This derivation exists only for the extra current. It is analogous to a safety-valve, which opens automatically at a given pressure.—*Comptes Rendus.*

A SHORT HISTORY OF INCANDESCENCE LAMPS.

By A. GÉLYI.

(*Concluded from page* 113.)

Swan now abandoned his experiments with the electric light until the year 1877, when two circumstances occurred which caused him to resume them. The dynamo-electric machine had assigned to the question of the electric light quite a new field, transferring it, as it were, from the regions of the scientifically interesting to those of the practically useful. On the other hand, Sprengel had invented his air pump and his invention afforded the means of forming a far better vacuum than could be made with the old air pumps. Crooke's experiments with the radiometer and the simultaneous experiments of Stittorf, Puluj, Goldstein, and others, showed the degree to which gases could be rarified by means of mercurial air pumps. Swan had the good fortune to make the acquaintance of Mr. Stearn, who was already considered as a great authority as regards perfect vacua, and this was the second circumstance which encouraged Swan to make, in conjunction with Stearn, another attempt to solve the problem of electric lighting by means of incandescent carbon lamps. We have already mentioned that, during the interval between the first and the second period several experimenters attempted to produce practical carbon glow lamps, and that their efforts were not crowned with success.

Against the different attempts that were made to render the principle of incandescent carbon in vacua practically useful, there were two great unconquerable difficulties; namely, firstly, *the rapid consumption and consequent breaking of the glowing carbon*, and, secondly, *the light becoming obscured by a kind of black smoke.* These two phenomena appeared so uniformly and regularly that the volatilisation of the carbon under the influence of the intense heat was assumed to be the cause of the glass globes becoming black. Fortunately Swan attached no great importance to these experiments, which appear to point out that the carbon becomes volatilised under the intense heat to which it is subjected, which inevitably renders the globes black. He was aware that the circumstances under which all previous experiments, without exception, were made, were not such as to ensure the experimenter even an approximately perfect vacuum. For the closing of the different openings of the lamps, screws were exclusively used, and the vacua were formed by means of an ordinary air pump; under such circumstances it was unavoidable that a comparatively considerable volume of air remained in the lamp; it was also thought that the gas contained in the carbon was set free by the electric current heating the carbon; moreover, sufficient care was not taken to make the resistance of the connections smaller than that of the glowing part of the carbon. Swan fully understood *that the carbon must previously be heated to whiteness in a good vacuum, and that this must be effected under more favourable circumstances than before.*

With this view Swan sent, in the year 1877, to Mr. Stearn a quantity of carbon strips made of carbonised cardboard, with the request that he would cause them to be mounted in glass bulbs, which were then to be exhausted as perfectly as possible. Stearn undertook with the greatest readiness that delicate operation, which he carried out with rare ability. In order to obtain a good vacuum it was necessary to raise the carbon, by means of the electric current, to a very high degree of heat for the purpose of setting free the gases contained in the carbon, which could then be removed during the process of exhaustion. In order to establish a good connection between the carbon and its supports, the ends of the carbon strips were made thicker. Those essential conditions having been strictly complied with, several difficult experiments proved that, *when the vacuum in the glass bulb was good, and the connection between the carbon and the conductor on which it was mounted sufficient, the glass bulb did not become blackened, whilst the consumption of the carbon was infinitesimally small.* Thus was then a difficulty overcome which had prevented, for a long time, the attainment of successful results in this branch of electrotechnics. It only remained now to perfect the several parts of the lamp to discover the best material for the carbon, and to fix the carbon filament in the lamp in a suitable manner. Swan and Stearn, by their joint efforts, succeeded completely in solving those problems, and the result was the construction of the first of those glow lamps which appear to be destined to introduce the electric light everywhere, and to supersede more and more the means of illumination hitherto in use.

Summarising the above account of Swan's lamps, we find that they differ in some details from those at present manufactured by the Swan Company, just as the Edison lamp of the present day differs from that to which his first patent relates. At all events, the above-mentioned lamp of Swan, which was publicly exhibited in the year 1878, possessed all the essential characteristics of the modern glow lamp in so far that it consisted of glass, carbon and platinum, and that no other substance was used in its construction. The carbon was mounted on platinum wire, which was hermetically sealed into the glass globe. The vacuum was formed by means of a Sprengel air pump. The exhaustion of air, &c., took place whilst the carbon was being heated, and the vacuum was made very perfect. These are all essential characteristics of the present glow lamps, and, as far as we know, the fundamental conditions of a practical glow lamp.

After Swan's success, Edison constructed at last a glow lamp fit for use. After he had realised in the year 1878, by the failure of his platinum glow lamp, that that metal cannot be used in the glow lamps as glowing substance, he resolved at last to follow in the path of the majority of his predecessors, and to use carbon instead of platinum for his glow lamp. Also on this occasion the genial electrician displayed an obstinate activity which no difficulties could deter. As the question was to discover the most suitable species of carbon, he commenced his researches and experiments on a scale as extensive and costly as in the case of the metal glow lamps. Like Swan, he begun by using carbonised cardboard, and again was the first experiment, which was only partially successful, trumpeted forth by the agents of the Edison Electric Lighting Company as "the newest, unsurpassable, and most perfect invention;" and the Stock exchange speculators, who learn with difficulty and forget so easily, allowed themselves to be duped again. The shares of the Edison Company which, in consequence of the first *fiasco*, could scarcely find buyers at 20$ per share, were eagerly taken up at 3,500$, and many shareholders refused to part with their shares even at that exorbitant price!

Whilst the greater part of the English and Continental press took for granted the tirades of their American colleagues, and spread them amongst their readers, the Parisian *Temps*, in order to throw a light on the state of affairs, applied to the celebrated electrician Count du Moncel for his opinion, who replied in a long letter. We will give a few extracts from that exposition, which abounds with true French sarcasm.

"Allow me," thus the letter commences, "to express my astonishment at the excitement recently caused in the money markets by the incredible puff which I read in the New York *Herald* relating to Edison's new lamp, which is vaunted as 'a great invention' and 'a great triumph.' We must really have lost all recollection of the 'American ducks'* if we allow ourselves to be imposed on by such pretensions; for, besides that this system offers nothing new in principle, the new puff appears to have been inspired by an idea, which we can easily guess, if we refer to a communication of Mr. Goddard, the secretary of the Edison Lighting Company, namely, 'that thus far the sole object of the Association is to afford Mr. Edison the means to continue his experiments; that the company, if those experiments succeed, will make large profits, but that if they fail it will be dissolved.' This communication concludes with the rather naïve statement that the idea of the 'Sorcerer of Menlo Park' is excellent, but that it 'is still a long way from its conception to its realisation.' What surprises me is that people, after the cries of alarm which went up from Menlo Park on several occasions, still allow themselves to be captivated by the assertions of the reporters, and take Edison for an oracle. Mr. Edison is indeed a very ingenious and fruitful inventor, but further he is nothing, for he does not even appear to be acquainted with the subtility of electric science, and of the discoveries made long ago. In the case of his telephone it has already been proved that its very principle does not belong to him; and after careful examination we might prove, likewise, that the idea of the phonograph, if not its realisation as well, are not his either. His first lamp was only a modification of that of De Changy, in the year 1858, and that which is at present brought under our notice appears to be nothing more than a modification of the lamps of King, Lodyguine, &c.

"It is possible," Du Moncel goes on to say, further on, "that the invention in question is better than that of any of his predecessors, but it is very far from being represented by the invention that is so extravagantly praised in the American journals . . . . We may say the same of the dynamo-electric machine of the same inventor, which offers nothing new, and relating to which theories have been formed, which, if they were true, would modify the laws discovered by Ohm and by Joule, and would be in contradiction with the theories experience has taught us of other machines . . . .

"Allow me, in conclusion, to protest against the unceremonious manner in which '*Messieurs les Americains*' treat European inventions; it is scarcely to be believed, but they appear to imagine that the electric science has only recently been brought to light, and that it is America who discovered it."

That Du Moncel's somewhat sharp criticism is perfectly justifiable, a rapid glance at the history of the glow lamp will prove; besides, his conclusions have been borne out by facts, for Edison's glow lamps with filaments of carbonised Bristol board did by no means realise the expectation of the inventor.

But those disappointments could in no wise discourage the restlessly active mind of Edison; on the contrary, they goaded him on to more strenuous exertions.

As he had formerly searched the globe for the most different minerals in order to discover a metal suitable for his glow lamp, so he now despatched experienced and able emissaries in all directions of the compass with the charge to find a vegetable matter from which a useful carbon filament could be made. He might have obtained what he required in his immediate neighbourhood, for in the cotton, which grows in the United States in such a large quantity, are united all the conditions which render it most suitable for glow light purposes, if it was not that Swan, who had already preceded him in the construction of a carbon glow lamp, also anticipated him in the use of cotton thread for his filament. Edison was consequently compelled to search the far East for that which had already been found to exist in his own country in an inexhaustible quantity, a substance from which to prepare his filament.

After long and exhaustive experiments Edison decided at last to prepare his carbon filament from a species of bamboo, and after having effected a few improvements of the details he too succeeded in constructing a glow lamp which sufficiently fulfils the conditions to render it fit for practical use. This lamp is, especially in America, extensively employed.

The success of Swan and of Edison induced other electricians to construct carbon glow lamps, and at comparatively short intervals appeared the glow lamps of Maxim, Lane-Fox, Müller, Nothomb, Puluj, Bernstein, Gatehouse, Woodhouse and Rawson, and, quite recently, that of Mr. R. Von Bernd, of Wiener-Neustadt. The lamps of those inventors all agree as regards their chief principles with those of Swan-Stearn and of Edison, but then those very principles had already been recognised for decades as essential, and the only novel and distinguishing features of the present lamps relate, not to principle, but to more or less perfection of construction, the shape of the glass bulb, and, finally, the substance from which the carbon filament is prepared, and its form and thickness.

As an interesting fact we must not omit to mention here that a few months ago a young electrician, Mr. Max Von Bernd, of Wiener-Neustadt, has succeeded in restoring by a very simple process the disintegrated carbon filaments, and thus repairing the lamps which were no longer fit for use. This promises to be of immense importance with regard to the working expenses of the glow light illumination, and may be said to mark an epoch in its history.

And so we see the electric light, thanks to the persevering efforts of the most able and industrious electricians, who toiled for decades, brought at last to such a degree of perfection as to open up for it an ever widening field of usefulness; to ensure it, as it were, an entrance into the palace as well as into the cottage.

THE RE-WINDING OF DYNAMOS.

[A COMMUNICATION.]

IN a back number of the ELECTRICAL REVIEW I notice an enquiry which I had previously overlooked, for the formulæ necessary to calculate the proportion between the resistances of a field-magnet when it is in derived or direct circuit.

I have given the full information on this subject in the ELECTRICAL REVIEW of June 9th, 1883, from which the following formulæ is taken:—

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* AMERICAN DUCKS.—A French writer, in ridicule of the extravagant stories of the day, set afloat an absurd story in regard to the extraordinary voracity of ducks, alleging that twenty having been placed together one of them was killed and cut into small pieces, feathers and all, and thrown to the other nineteen, who immediately swallowed it; the same thing was repeated until at last but one remained. The story was circulated in nearly all the journals of Europe, and, after several years, was revived with some additions in America.

If it is required to change a field-magnet from a direct into a derived circuit or *vice versa*, it is necessary to re-wind both the field-magnet and the armature with wires of a different gauge ; but the work that the dynamo will perform in the exterior circuit will be the same whether its field-magnet is in direct or derived circuit, providing both the armature and field-magnet are both re-wound to correct resistances.

Let L equal the resistance of the circuit exterior to the dynamo, and R and r the field-magnet and armature resistances of the dynamo having its field-magnet in direct circuit, and R_1 and r_1 the resistances of the field-magnet and armature when the field-magnet is in derived circuit.

Then the value of R_1 and r_1 in terms of L R and r should be

$$R_1 = \frac{L^2}{R} \quad \text{and } r_1 = r\left(\frac{L}{L + R}\right)^2$$

or the diameter of the wire of R_1 would be $\sqrt{\frac{R}{L}}$ times the diameter of R, and the diameter of the wire of r_1 would be $\sqrt{\frac{L + R}{L}}$ times the diameter of r. Similarly the diameter of the wire of R would $\sqrt{\frac{L}{R_1}}$ that of R_1, and the diameter of the wire of r would be $\sqrt{\frac{R_1 + L}{R_1}}$ that of r_1.

If it is required to transfer a portion only of the wire of a direct field-magnet circuit into a derived circuit, let that portion of the field-magnet remaining in the direct circuit have a resistance of $\frac{R}{n}$, and the portion transferred to the derived circuit have a resistance of R_2, and let the resistance to which the armature is re-wound be r_2

Then

$$R_2 = \frac{\left(L + \frac{R}{n}\right)^2}{R\,\frac{n-1}{n}} \quad \text{and } r_2 = r\left(\frac{L + \frac{R}{n}}{L + R}\right)^2;$$

and the diameter of R_2 would be

$$\sqrt{\frac{R\,\frac{n-1}{n}}{L + \frac{R}{n}}} \text{ that of R}$$

and the diameter of r_2 would be

$$\sqrt{\frac{L + R}{L + \frac{R}{n}}} \text{ that of } r.$$

If a dynamo wound with a derived field-magnet circuit is changed into a compound dynamo by putting $\frac{1}{n}$ of the conductor of the field-magnet into the direct circuit, then the resistance of that part of the field-magnet in the direct circuit should be made $\frac{R}{n} = \frac{L^2}{R_1 n}$ and the resistance of that part "R_2" which remains in the derived circuit should be re-wound to

$$R_2 = \frac{\left(R_1 + \frac{L}{n}\right)^2}{R_1\,\frac{n-1}{n}},$$

and the resistance to which the armature is re-wound should be

$$r_2 = r_1\left(\frac{R_1 + \frac{L}{n}}{R_1}\right)^2$$

and the diameter of the wire of R will be $\sqrt{\frac{L}{R_1}}$ that of R_1, and the diameter of the wire of R_2 will be

$$\sqrt{\frac{L\,\frac{n-1}{n}}{R_1 + \frac{L}{n}}}$$

that of R_1, and the diameter of the wire of r_2 will be $\sqrt{\frac{R_1}{R_1 + \frac{L}{n}}}$ that of r_1.

W. MOON.

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(*Reported specially for the "Electrical Review.*")

(*Continued from page* 117.)

Mr. VANDYKE : I hope that people will not be discouraged in working in the line of other batteries besides the lead one. I think there are cases in which a battery is sure to have a long life, and sure to keep itself charged without loss to a great length of time.

There are many uses for such a battery as that, and my own work satisfies me that the zinc, alkali, and copper battery will fill a considerable want. As, for instance, in running the magnetic apparatus in observatories and work of that kind. I have made a small battery of that kind, using a spiral of copper above and putting amalgamated zinc below so as to avoid the falling down of the deposit of zinc upon the copper, thereby amalgamating the copper, and rendering it far less efficient. Although the electromotive force is only 97 or 98 hundredths of a volt, still we found by actual trial that charging the battery, taking the readings at the time, and then letting it stand for two or three months, there was not enough difference in the readings to show the slightest loss ; the battery retained its charge, so far as we could find out by the means at our command, perfectly for two months, which I think is a good showing. I was anticipated in reference to using zinc and oxide of copper in the public statement that was made that there was no action of the alkali upon the oxide of copper. Still I was delighted to find the oxide formed in the oxide of copper was impervious to the action of alkali. The only difficulty which I found in using a battery was a rather curious one—that you had to be very particular about the electromotive force to be used in charging it.

I have not finished my experiments so as to state precisely the electromotive force, but it is somewhere between a Daniel and a Grove. If you charge a cell of that kind with a Grove cell and continue it you will find that the copper strip will be altogether dissolved by the alkaline solution, forming the cuprate of soda or potash, according to the alkali used. Then that breaks up in forming the oxide of copper.

But if you are particular about not running beyond the Daniell, there is no such difficulty experienced. Taking hydrate of soda, pure electrolytic copper and zinc deposited in mercury so as to be kept pure, I found it was not due to any salt (sulphate of soda, or anything of that sort), of the alkali used. In experimenting I found further that you could use a double amount of chloride of sodium, or *ad lib.*, so as to bring down the resistance of the cell. I am by no means satisfied that even with low electromotive force, there would be much resistance for a small cell. The resistance would evidently be reduced very low indeed, and such a cell as that could be maintained, so far as I can see, indefinitely. The one precaution that is necessary to be taken is merely to throw a heavy mantle over the top to shut out the air.

I want to say a word on the carbon question. I am interested to know whether anybody has succeeded in producing oxygen on carbon to any considerable extent without disintegrating it. I have had great difficulty in that way in my experiments with the secondary battery in using a carbon plate and trying to deposit oxide of lead upon it electrolytically. I have found it would lead to the disintegration of the carbon by means of the oxygen. Hydrogen does not do it at all. Suppose you place a carbon disc in place of a platinum disc in an ordinary voltaic battery ; you will soon discover how long that carbon will last. The oxygen seems to have the power of accumulating in the pores and crowding out the carbon more than the hydrogen does. I think that this matter of the copper battery is worthy of passing mention, because I can see those cases arise in which we should like to have a battery that we could charge and know we could depend upon, even after several months, not to lose its charge.

I am positive that anybody who tries it would be pleased with the properties of the copper battery made in the usual way with amalgamated zinc and alkali, either soda or potash.

Preference may be given to soda, on account of its being so much cheaper. The method should be to use plenty of chloride of sodium in it.

I think the tendency of the copper to dissolve and to break up into cuprate was not any greater when the soda was used.

Mr. KOYLE : I just wish to inquire of Prof. Vandyke how his carbon is made, as that makes considerable difference. If they are formed by the ordinary method out of coal tar carbonised they are very fragile and disintegrate in the battery. But if formed in the manner I speak of from coal tar, pure and simple, so that they seem to form a very much more homogeneous mass, there is a striking difference in the permanency of the plates.

Prof. Vandyke: I will state that I use the commercial carbon simply.

Mr. Koyle: I think that there is a great deal of difference between the secondary battery composed of carbon plates and one composed of lead plates. I do not see myself the reason for such an expression of opinion, that the Planté battery is more scientific than any other batteries, a Faure-Sellon-Volckmar battery, for instance. It is easy to construct a Faure battery that will last forever, if you only make the plates large enough. But the battery is going to continue disintegrating from day to day. Lead has some weight, as is well known, and when you are going to make a Planté battery of sufficient size to last any length of time, you will make a secondary battery of enormous weight. For any other purpose than putting down in a cellar to let it stay there, the weight is a great factor. I think that a battery composed of lead plates a foot square, the ordinary size will weigh something like sixty pounds. I do not guarantee that exactly, but I believe it is in the neighbourhood of sixty pounds. A square of carbon plate of the same size weighs about three-quarters of a pound. Now a battery made of eleven plates of this size gives you something like 60 or 70 pounds. If you want to use electromotive force of 100 volts, as in some cases you do, it would require fifty of these cells, of 60 pounds each, which would give you about 3,000 pounds, and that outside of the weight of the electrolyte and the box. Carbon plates will make a difference of about 80 per cent. Instead of 3,000 pounds it will be about 600 pounds all told, and the carbon plates will have the advantage of always remaining intact; they will not disintegrate, and will remain permanent so long as the box will or anything else about it.

Mr. Elihu Thomson: I should like to have a method which will tell whether the plates will disintegrate or not. Look on the plates that receive the deposition of peroxide of lead. Suppose we were to locate one particle of oxide which has been formed from the surface of the lead, what will be the electro-chemical conditions of that particle? Evidently the peroxide itself is in an electronegative condition, far more so than the lead. Consequently it will set up a local circuit and distribute its oxygen more or less to the surrounding lead, and thereby eat into the lead, deeper and deeper, destroying the life of the battery in time. It would seem from this consideration alone that the lead battery is certainly limited in its life.

Let us take the case of the carbon plates. Has it yet been proved that carbon is stable in the presence of peroxide of lead in contact?

Perhaps this may disintegrate the carbon and oxidise it into oxide of carbon, and at the same time reduce the peroxide of lead to the protoxide of lead (PbO).

We have these two different substances, one highly electronegative, and the carbon perhaps may be inert, but then, though it may be different in an electromotive force ever so slightly, we will have a local circuit which will take oxygen from the peroxide of lead and oxidise the carbon. If we wish to make a test of that let us take a massive piece of peroxide of lead. Take a specimen of the carbon which is to be tested and attach it to the other side, putting in the circuit means of testing a feeble current. Take an electrolytic liquid, for instance sulphuric acid, and see whether we have a difference of electromotive force between those two substances. If there is no such difference then the stability of carbon in contact with the peroxide of lead will be established. It may be, also, that the states in which carbon is known to exist may control the matter to some degree. The artificial plate made of carbon, which undoubtedly must be of a porous nature, and would naturally be expected to disintegrate more readily than the plate which had been made from tar, which had been coked into a porous condition, because the tar deposits its carbon in flakes, little bubbles separating them. This is seen in the plates of carbon obtained from petroleum manufacturers, which is intended to be used in making electric light carbons. The mass appears as a solid plate below, and above it is a confused mass of broken bubbles which can be planed down to show cavities of various sizes, the cavities being smaller as we approach the surface of the carbonising vessel, which is wrought iron.

There is another condition that might govern the condition of the carbon, and that is, we may take this carbon and heat it to a temperature that would convert it into the graphitic variety. It is well known that if we take a stick of carbon and put a current through it of a sufficient degree to almost vaporise the carbon—in other words, to make it almost as hot as the carbon in an electric arc light—at the extremity it undergoes a change of condition into the graphitic variety; in fact, it takes a plastic form. I have often made carbon rods as thick as a quarter of an inch in that way.

You can take this carbon and write with it as with a lead pencil. Whether it would be suitable in that form is another question.

Prof. Newcomb: Speaking of subjects that are connected with the subject of storage batteries, I wish to call your attention to some experiments made by Elihu Thomson and myself prior to 1878, in which we used two plates of copper, an electrolyte of sulphate of copper and a plate of metallic zinc. In passing in a current through them a deposit of metallic zinc was formed. We found an excellent effect was obtained in that way.

Lieut. J. E. Jewell: There is one point I have noticed that is of practical use in reference to secondary batteries, and that is as to the inequalities in the various styles of batteries. I have had an experience of six months with one form of storage battery, the commercial battery as it is now in use, on a lamp circuit. As it is arranged it is used for lighting 40 incandescent lamps, although we have only 10 or 12 of these lamps in use at any one time. Consequently the demand on the battery is not very great, and hence, in charging the battery, we find that with a 20 ampère current, instead of having to charge the battery all day, as I believe would have to be done in case the whole 40 lamps were to be used, we charge for two hours in the morning, or until the cells give off gas from the plates, when we consider the charging as completed. I believe after three weeks' use of this battery it was observed in the first place that the lamps were not up to their usual standard of power. The next morning it was found that certain of these cells, four or five of the 21 that formed the battery, were much lower in their measure of electromotive force than the other cells of the battery. It was thought, in the first place, these cells might, perhaps, have become exhausted by short circuits; but from very close examination there were revealed no short circuits in the cells, and, furthermore, when the charging current was put on again, those cells were the first of the whole battery to give evidence of being charged. In other words, it would seem as if the storage capacity—if I may use that expression with regard to those cells—the storage capacity of these particular cells had been diminished in some remarkable way.

We restored those cells by a process, the process which we were instructed to use in the first place. A battery was first set up; that is to say, by a prolonged charging of the whole body—a charging of some 20 hours with a current of 20 ampères, and then a discharging of the whole battery on a fixed resistance which was about equal to the lamp resistance, say, ·8 of an ohm; then another charge of 20 hours with a 20 ampère current and again discharging the battery for three or four hours on this fixed resistance; then recharging for 20 hours. At the end of that time the battery was in good condition again, and those particular cells which we had found had given out before did not give out again for several days; but in every case, I think, where that process has been repeated three or four times, it finally takes about three weeks for these batteries to give out. I don't remember exactly now whether the same cells were involved, but I think that out of the five or six cells four have been involved every time. We occasionally find another cell going in the same way, and I think it is a question of time when all cells will probably behave in the same way. Otherwise the cells which have not given any trouble are good cells. The whole resistance of the battery is very low, and the electromotive force is very constant, with the exceptions that I mentioned, and the light is very satisfactory. But I am not at all sure that Mr. Preece has found a solution of the lighting question by means of the secondary battery. It is to be hoped that he has. My experience rather indicates that we have not got a storage or secondary battery which is a practical instrument.

Mr. Preece: I would like to reply to some of the observations that have been made, and in the first place I should like to corroborate what Prof. Carhart said about the percentage of energy we recover from the storage battery and utilise in shape of light.

Very recently Prof. Dewar was kind enough to make a calculation for me that brought out a very interesting result. I wanted to know the relative proportion of energy expended in different modes of artificial illumination. I wanted to know how much was expended in the sperm candle to give one candle light, and how much in a gas flame, and how much in electric lamps. The result of Prof. Dewar's calculation was to show that in a sperm candle for one candle light we expend 97 watts. The experiment with gas showed that for every candle given out 62 watts were consumed. Now I have been experimenting with various incandescent lamps, and one lamp gave a result showing that it was possible to obtain one candle for 2·5 watts. While with arc lamp illumination, such as we use in the street, we get a candle for each watt expended, and if the arc lamps were bereft of the hideous structures put around them to destroy or reduce their light, we should probably get a candle for each half watt.

That shows the proportion of one per cent. Prof. Carhart named must be within the mark. For if we can get one candle for the expenditure of one watt, and we otherwise expend 97 watts in the process, it is clear that 96 watts must have been wasted. There is another point that arises out of this to which I want particularly to call your attention, although I am afraid I am going to promulgate a doctrine which may induce many of you to set me down as very paradoxical.

My doctrine is simply this, that I believe the days of the arc lamp are numbered, and that all the lights in the future will be furnished by the incandescent lamps. My reason for saying that is simply this, that up to the present time in the incandescent lamp, such as we have, the light is produced by the expenditure of from 4 to 5 watts per candle. Improvements, and very rapid improvements, are being made in the form of the carbon filaments. We are now using lamps in England that give us light with an expenditure of only 2·5 watts per candle. If improvement goes on at this rate I am quite certain that before another decade we shall have incandescent light that will give us one candle for each watt. When that is the case, then the incandescent lamp will be used in place of the arc. The arc requires constant personal supervision. It requires mechanism to keep it in order. It only lasts a short time, whereas the incandescent requires no attention whatever after it is put up, and its life is very considerable indeed. In London, lamps can now be obtained whose life is guaranteed to be a thousand hours. I believe on this side of the water they are guaranteed to a certain extent, I do not know what, but if we can get incandescent lamps giving a light at the expenditure of 1 watt per candle, and whose life will be over 1,000 hours, then it will be a case of good bye to the arc lamp.

There was one other point that I did not mention in regard to my battery, and that was I am using only 17 cells. I am using only 30-volt lamps, and I use them for security. First, because it gives me very few cells to keep in order, and secondly, because the electromotive force is so low that there is not the slightest fear of shock, and consequently there is not the least fear of fire due to a short circuit or imperfect action in any of the insulating means.

In isolated houses, the lower you can reduce the electromotive force, the safer it will be. It is only where the houses are isolated that the question of low electromotive force comes in.

(*To be continued.*)

THE DISTRIBUTION OF ELECTRICITY.*

In the last lecture we were engaged in preparing the way, as it were, for considering in detail the different schemes which have been proposed for laying the mains from a central station; and the laws which we established in that lecture are applicable not only to a large central station, but even to private installations. I pointed out that there were three different reasons why we cannot seek for economy by diminishing the size of our mains very much: the first is that it is an actual waste of money in consequence of the energy which must be used up to heat those mains; in the second place, when we diminish the size of our mains the heating being increased may cause serious inconvenience in several different ways; and, in the third place, when we have thin conductors, the fall of potential as you go away from the source of electricity is very much increased. I dealt pretty fully with the first two points, the waste of energy in the conductors—a consideration of which leads us to the consideration of the economical size of conductors to use—and, secondly, the heating of conductors. Now let me insist once more on what I spoke of with regard to the economical size of conductors. We must in all our plans for laying mains determine the economical size of conductors by Sir Wm. Thomson's law, and nothing must allow us to deviate from that size of conductor. When we have really accepted this fact we have done a great deal. Very few large stations have been designed on this correct principle. I may mention, for instance, that in the central station in New York there is, as Dr. Fleming informs us, 52 per cent. horse-power wasted between the cylinders of the steam engine and the lamps. Some people have been tempted to depart from the law of the economical size in order to get over the difficulties of the fall of potential, but, as I said last night, these difficulties in regard to the fall of potential must be met as engineering difficulties which can be got over, and we shall see in the course of these lectures that they can be.

Now we will come to the question of the different systems of distributing our lights. There are several systems which merely depend upon the way of laying the mains; there are other systems which depend upon the introduction of auxiliary appliances. Those which depend upon the way of laying the mains are indicated diagrammatically on the table before you here. (Fig. 1.)

First comes the simplest form, the series, in which all the lamps follow one another in series on a single conductor. Next we have examples of multiple arc systems; in the first one, which I call the parallel line, two conductors diverge from the dynamo, and the lamps are put on across the lines. In another kind of multiple arc system, which I call the reversed parallel line, there are two conductors going the whole way round, one end of one of the conductors connected with the positive pole of the dynamo, and the other end of the other conductor connected with the negative pole of the dynamo, and the lamps are placed across these two conductors. Beside these two systems of multiple arc arrangement there are several others which I shall treat of presently. Passing from these multiple arc arrangements we come to an arrangement which may be called the multiple series, where we have a number of conductors—numbered 1, 2, 3, 4, &c.—the first of which is connected with the positive pole of the dynamo and the last of which is connected with the negative pole of the dynamo, and the lamps are placed, some between 1 and 2, some between 2 and 3, and so on.

The oldest arrangement which was proposed for establishing extensive systems of electric lighting was on the series arrangement; in fact in reading over the evidence given before the House of Commons Committee in 1879 you will find that the series arrangement is the only one spoken of. In using it for incandescent lamps of course the trouble is that there is such a limit to the number of lamps that can be used; that number is limited by the potential, the pressure which we are able to use in our mains. Up to the present time the highest pressure which has been used, that I know of, for any length of time on satisfactory and commercial principles is 5,000 volts. Well, but if we have our lamps of 100 volts each, then 5,000 only gives us 50 lamps; we should only be able to put on 50 lamps to a series. That is a serious drawback. Another drawback is that if one of these lamps goes out the whole will go out, so that it would be necessary in such a system to have an automatic arrangement so that when one lamp goes out it shall shunt that lamp. It is clear, then, that if we want to increase the number of lamps in our series, it will be necessary to use very low potential lamps, while in the multiple arc system it is desirable to have them of as high potential as possible. In series it is best to have a low potential; but this has a serious objection. If we shorten the length of the filament, or if we thicken the filament so as to diminish the resistance we make the cooling effect of the terminals very great indeed. This is very evident in an incandescent lamp that has a very thick filament, such as the Bernstein and the Lodyguine lamps. I think we may safely pass over the question of putting incandescent lamps in series. Arc lamps put in series are eminently successful, and the arrangements adopted in America for keeping the current perfectly constant are such as to shut off any number of lamps, and keep the others working well. I see around me several gentlemen of the British expedition to America last year, and I think everyone must have admired the working of the central arc lighting. When we were in Philadelphia—I speak of it because I know it best—whether we were in the dynamo room, where we saw numbers of dynamos at work, or whether we were walking through the streets admiring the graceful festoons of overhead wires and the elegant steel poles on which they were suspended, and feeling the benefit of the graceful wires and powerful dynamos to thousands of our fellow creatures, we could not help feeling admiration for these central stations.

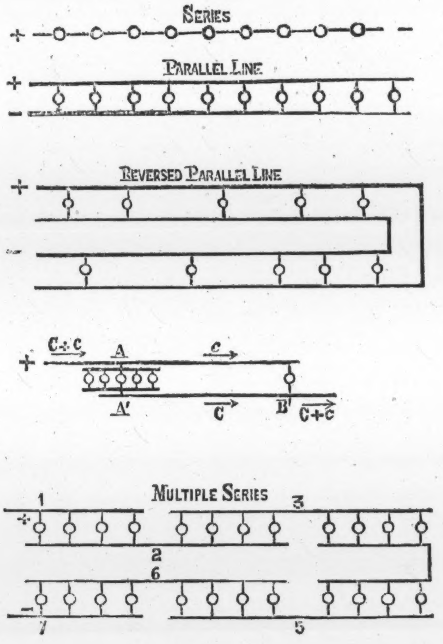

FIG. 1.

I now come to one of the most important systems of distribution, the multiple arc system. It is the most important for this reason, that it has received the greatest amount of attention in the past. I do not say that it gives the greatest prospect of success in the future. When we come to speak about the multiple arc system, first of all I wish to direct your attention to the necessity for having as high potential lamps as we can. I am informed by Mr. Swan that if there were a demand for it, there would be no difficulty in procuring a 20-C.P. lamp, of as long a life as those which are made at present, supplied with a pressure of 400 volts. With this authority, I am simply surprised that the thing has not taken a more practical shape. It is a most important thing, as you will easily see when you think that a 20-candle lamp with 400 volts, of equal economy, equal life, with the present lamps, means that the number of lamps which a good conductor would give would be enormously increased. Let us first take the simplest case there is of distribution by the multiple arc system, that is a street with conductors going along a single street, as shown in this diagram (Fig. 1); and we should also consider the case of this reversed parallel line as I have called it. Now you notice I have made these conductors tapering, because, theoretically they ought to be tapering, and practically they must be as nearly tapering as they can be, the reason being that at every point the section of the conductor must depend on the current it is to carry. Now the first thing that strikes us in this system is the very serious obstacle, the falling off of potential. I have assumed, for the purposes of illustration in these lectures, a certain size of conductor, 1½ square inches to every 1,000 ampères. That is not in the least the size that must necessarily be adopted, that must depend on local circumstances; but we must have a certain size to continue, and we will take that. When a conductor of that size is carrying that current, the fall potential is constant whatever the thickness of the conductor may be, because the fall of the potential is not only proportional to the resistance of the conductor, but also to the current which it is carrying. Of course when the number of lights is diminished, the current will be less and the fall of potential less.

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* Cantor Lecture, delivered by Prof. George Forbes at the Society of Arts, February 9th, 1885.

It has been proposed to supply all parts of a district with lamps of the same pressure, and to make up for the increased pressure of the conductors near the engine-house by inserting resistances into the lamps, a high resistance in the first and less as you go along, until there is no resistance at the most distant lamp. This is quite intolerable; it is a most objectionable thing to have to introduce resistances, which are simply using up energy. It is also proposed to use adjustable resistances, so that when fewer lamps are on there shall be not so much resistance, and that these should adjust themselves automatically; but any introduction of resistances like that is very much to be deprecated.

Now what is the greatest distance on such a multiple arc system which we can work with economy? That depends upon the variation of potential which we allow. In the Edison lamps of 100 volts, I find that the fall of C.P. at or near the state of normal incandescence is about one C.P. for every volt. I think it would be admitted that a variation of 4 per cent. is about all that we can allow in the pressure. Remember that in this I am obliged to consider the engine as perfectly governed, that is that the electromotive force in the engine-house is perfectly under control. We will allow 2 per cent. up and down, 4 per cent. altogether. Let me show you how it will be necessary to arrange the lamps. Here is a length of conductor separating two lamps; the pressure required for the lamps is 100 volts. I raise one to 102, or a pressure two above its normal, and lower the other to 98, two below. We are able, by giving one station a lower potential lamp, and the other a higher potential lamp to make a greater variation without allowing either of them to go more than two per cent. above or below its normal character. Let the near lamps be of 102 volts and the distant ones 98 volts. When all the lights are on, let one be raised to 104 and the other lowered to 96; when they are all off, let the one be lowered to 100 and the other brought to 100 too. There is never more than 2 per cent. above or below, yet we have a range of 8 volts allowed for the drop in the conductor when all the lamps are on. This is simply to show you that we can by stretching a point work at 8 volts instead of 4. I am, however, against supplying a district by lamps of a different character; therefore I prefer to speak of 4 volts as the permissible fall in potential between the nearest and farthest lamp. Assuming that there is in 100 yards a fall of potential of 3·22 volts, which is the case with the size of conductor I have chosen, there is a fall of potential of 4 volts in 124 yards; therefore, on this assumption, if we supply a district with lamps of uniform pressure, the greatest distance which a lamp can be from a central station on economical conditions is 124 yards. This is a very serious thing, and shows how very limited is this parallel line system.

It has been proposed to get over the difficulty of the fall of potential by using the reversed parallel line. In this case, since one end of one conductor is connected with the positive terminal, and the other end of the other conductor connected with the negative terminal, it looks as if the potential would be constant at every point, and so it would be if the wires were properly drawn. You see I have made them tapering, and so they should be; but on the assumption that they are perfectly uniform it has been shown, first I believe by Prof. Ayrton, that the potential is not constant at different parts if there is a greater consumption of light at one part than at another. Mr. Kapp has also shown that even in the case of a uniform distribution of lamps along the whole circuit, if the conductors are of uniform thickness, the potential is not equal at every part of the line, but is greatest at the two ends; but you will easily see that if the resistance of the conductor at every point is inversely proportional to the current which is passing through it, then the potential at every part would be the same if we had the size of conductor at every point proportional to the current it is carrying. The size of copper which is to be used is exactly the same as if we had a single wire for every lamp, an independent wire going for every lamp in the whole circuit; there is exactly an equivalent mass of copper in every part. The tapering arrangement is also analogous; it is equivalent to forming a circuit for every lamp. And you will find in every system of distribution by multiple arc, a mass of copper equal to a separate wire for every lamp, this being the law of the amount of copper required in this system of conductors. What does it mean, this equalisation of potentials in this way? It simply means instead of leading the wires up and back again, we interpose an additional amount of copper for the sole reason of putting in resistance and carry that copper the whole of the way round our circuit. That is worse than in parallel line introducing resistance to equalize potential, because it is introducing resistance equivalent to the length of copper wire, and copper is a very expensive material. Why not make it of some much cheaper material, and have simply an ordinary parallel line with resistance interposed? I think you will agree with me that this short statement is absolutely condemnatory of the reversed parallel line. However, that system bears an analogy to the multiple series system, and for that reason the time spent in considering its conditions has not been wasted, because when we come to the multiple series system we shall understand better how the sizes of conductors should be proportioned.

I now come to the most important part of the arrangement of multiple arc systems, that is, the arrangement for lighting a large district. In the course of these lectures I have a good many special cases sometimes to take which are not applicable to general cases likely to come before the engineer; for example, the size of conductors, the permissible fall of potential, and so forth. Well, in taking the question of lighting a district, since it is impossible to deal with every special district, I have taken a single example. This diagram (fig. 2) is a plan of the City of Chicago, and, indeed, of several others in America, of which the names are utterly unimportant. The district is simply made up of rectangular blocks of houses, and I have taken this as an illustrative case to show how the mains would have to be laid. I shall show you that the mains would be laid on three separate systems. To the first system I give the name of tree mains, because it consists of a massive trunk starting from a central station, dividing off into branches, and separating again into twigs and leaflets, and the leaves may be supposed to represent incandescent lamps; then I shall have to speak of a modification of the tree system, which I shall call either the compound or the multiple tree system, in which case a number of different trunks or feeders go out from the central station to different parts, where they branch off; and, finally, I shall have a few words to say on what is called the network system.

The first thing which has to be done when a district has to be lighted, even before selecting the system of laying mains to be adopted, is to determine the probable consumption of electricity in different parts of the district. This is a very difficult thing to do, of course, and the engineer must bear in mind the fact that the best estimate he can make is probably at fault, and so give a certain latitude in his proportions to allow for probable errors. Another point which it is desirable to get is the probable consumption at different hours of the day and different seasons of the year. These are figures which would probably be fairly uniform in similar districts in different parts of the country, but I have not been able to obtain information on the point. At the same time, I have no doubt that, and especially at gas works, it must be perfectly well known what the average relative consumption is at each of the twenty-four hours, at the time of the longest day, the shortest day, and at the equinoxes. I should be very glad, indeed, if any gentleman here can furnish me with even approximate data on these points; the information would be very useful. In all the attempts which I know of which have been made to lay down a system of mains, whether it was done on the tree system or the network, there seems to have been a sort of haphazard in the preliminary choice of size of mains and the manner of laying, and then these have been worked up gradually and altered in one way or another. My object is to try to show you that the laws by which these things are to be decided are perfectly definite and clear. The history of research into the matter of distribution is chiefly to be found in the records of the Patent Office. There is nothing more interesting than to read through the various patents which have been taken out, especially by Mr. Edison, in the matter of distribution, and I am glad to take this opportunity of stating how strongly I feel the great forethought which was evinced by Mr. Edison in investigating the matter, so far as he did, at such a very early date in the history of electric lighting. Some of his most valuable and suggestive patents date from the year 1880, when the multiple arc system was in embryo. At the same time I must say that whilst his qualitative suggestions have been so admirable, when he has come to the quantitative determinations and to the actual laying down of the mains there have been some inexplicable fallings off; so much so, that really in his central station in New York a very haphazard way of laying down the mains has been chosen; and it would have been very well worth while to have calculated the results of the distribution on such a system on paper before laying them down, and I think then most of the difficulties they have now met with would have been foreseen and probably prevented.

That leads me to say another thing about the calculation of mains. When an expensive bridge, like the Forth Bridge or the Brooklyn Bridge, is to be built, people are not entirely regardless of the amount of metal they are going to put into it. They calculate the weights and strains of different parts with the utmost care, and not simply spend a few hours but months, and even years, in calculating out these different points. And it is much more important, I think, in laying electric lighting mains, where with 100,000 Edison lamps you have over a ton of copper for every yard run on the multiple arc system, and if you consider the amount of money expended, no amount of care and forethought spent in this direction is wasted time.

First, take the question of tree mains, or a system of mains which covers the whole district and the trunks of which are all connected together and to the dynamos. This system was treated very well by Mr. Kapp two years ago, but his views were founded not upon the economical size of mains, but upon the size of mains which would not vary the amount of potential more than the amount permitted by the Board of Trade. If he had viewed it simply on the economical size of mains he would not have got further than 124 yards, whereas he was able to deal with a much greater amount. Now let us see what is the size we may have with the money at our disposal. First, we have n, equal to the number of lamps; then r, equal to the greatest distance of any station; then we have e, equal to the electromotive force of the lamp; p, equal to the percentage variation allowed in the pressure supplied to the lamps. The quantity of copper in the mains in any district of a fixed size is evidently proportional to the number of lamps; it also varies with the most distant lamp in two ways—in the first case, the further you go the greater is the length of mains, but as soon as the length of mains is fixed, you must increase the mains so as not to let this fall of potential be greater than in a smaller district. For that reason it is necessary, when we increase the distance of the most distant lamp, we must increase the cost of our mains in proportion to r^2. Then the higher the electromotive force of the lamps the smaller the current, and it is inversely proportional to the E.M.F. of the lamps squared. Mr. Kapp found the cost equal to $k \cdot \frac{n\, r^2}{p\, e^2}$ where k is a constant quantity r is given in yards and e in volts, and p is percentage variation of pressure allowed. He found that when the lamps were evenly distributed over the district, k was equal to 1·2; therefore the total cost was equal to this quantity. Thus, if we were to take 60,000 lamps, n equal to 60,000, r the greatest distance equal to 700 yards, e the E.M.F. of an ordinary Edison lamp of 100 volts, p the variation of pressure taken at 2 per cent. up and down, then the cost of that installation would come out at £882,000. Now, I would show you how important in this case is the higher E.M.F. of our lamps. If we had 400 volt lamps the cost would be reduced to £55,125. As I have already said, such a system of continuous mains in this way is not consistent with economical principles beyond a distance of 124 yards.

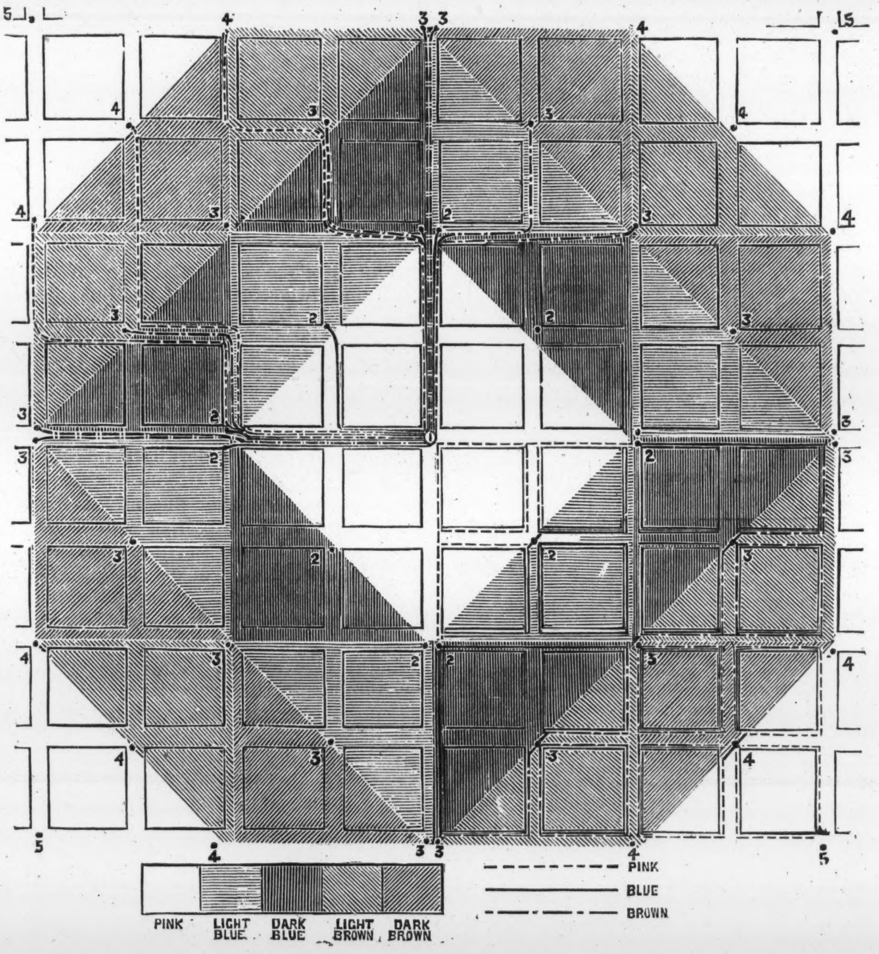


FIG. 2.

I will now speak to you of a system which I have called the multiple tree main. This system was patented by Edison in 1880 and was adopted by him and others at different times. Mr. Crompton proposed its introduction at Victoria Station in 1883, and actually adopted it to some extent in the Law Courts. The fall of potential of 4 volts in 124 yards is not necessarily between the station and the lamps, but between the nearest lamp and the furthest lamp which is supplied by that system of mains from the station, so that I might have in this way the central station here (indicating), I might have a very long feeding main, and then it might branch off and I might have one lamp here and other lamps over there (indicating), the distance being 124 yards, and the variation not more than 4 per cent. along the whole length of conductor, provided I keep that point properly adjusted. This was one of the systems provided by Mr. Edison in his patent. Now the way in which that ought to be carried out is shown in this diagram (fig. 2), which gives different coloured lines for the different feeder mains which will be required, and I have coloured the map in a special way. The pink centre is fed direct from the central station, the blue spaces are fed by distributing boxes marked 2, which are all 124 yards distant from the central station. I have assumed that the distance of two sides of one of these blocks of houses is 124 yards, only to make the thing simpler to describe. The brown district and distributing boxes indicated by the figures 3 are distant along the streets by twice 124 yards, equal to 248 yards, so the pink outside the district marked 4, is three times 124 yards. Then the number of distributing boxes which is necessary is shown here by the number of these marks, 2, 3, or 4 as the case may be. The number is fixed by this consideration, that the distance of the distributing boxes from the most distant lamp it feeds cannot be greater than 124 yards. And here I may draw your attention to an important point which has been almost always neglected in such a system of distribution—that in order to economise copper, the distributing box must be nearer the central station than any of the lamps which it feeds. It is almost invariable in schemes for this purpose to place the distributing box in the centre of the district which it feeds. As to the relative size of conductors in different parts of the district, you will see in this arrangement, as in the ordinary tree main system, exactly the same rule holds, that if you will take all the lamps in different parts of your district and lead wires by the shortest route that you can to the central station, then measure the proportional thickness of this bundle of wires in different parts of the route, then you have the most economical proportions of the conductors in different parts which can be given to it, and from the consideration of Thomson's law, you know not only the proportional size of the conductors, but the actual size in every part of the district. Here we have added a most important condition to our actual knowledge: in order to have economical mains we cannot have a lamp further distant from its distributing box than 124 yards, and that distributing box must be nearer to the central station than any of the lamps which it feeds. Thus, if the multiple arc system is to be adopted, this arrangement must be used if we are to comply with the conditions of economy, whatever the difficulties may be of arranging the potentials of the different parts. And here I may point out that it may be necessary to get the potentials of those distributin boxes at fixed amounts. This may be done either by inserting resistances into the trunks and into the feeders which go out from the central station (this is the plan which Edison adopts), or it may be done by using a separate dynamo for every distributing box, or by diminishing the E.M.F. by diminishing the resistance; by varying the magnetism of the field magnets; or, as Messrs. Willans & Crompton have been doing, you may govern your engine by an electric governor, which is regulated by the potential of these distributing boxes, so as to keep that potential constant; or you may proceed in other ways: you may have large dynamos to give you 100 volts in all your mains, then you may put in smaller dynamos in large quantity capable of increasing the E.M.F. by a similar amount, and thus may supply the different centres of distribution. These are points to which I should like to devote a very long time, for a great deal can be said about them; but it will be impossible for me to get through the simple matter of laying mains if I go into the question. Therefore I must omit further reference to it, as well as to the other important matters connected with the general scheme of distribution.

Now as to the cost of this system of conductors; you will find that the cost is not nearly so great as with the tree main system. I will give you the data required for calculating out the cost. What is the cost of the feeder to the first nearest distributing box—that is, 124 yards? That is the same as the most distant lamps in any square. Therefore that portion of a feeder which lights up a square requires twice as much copper as the copper that is in the square. Some of the supply wires of the square go the whole length of 124 yards, but some of them are very short indeed, and the average length of wire in that square is half the length of the feeder main—so that up to the first distributing box the feeder main has twice as much copper as the district which it feeds—therefore the whole length of the feeder to No. 3 feeding box has four times as much copper as the spaces which it feeds. These are the principles on which you must calculate the expense. You will then find that in the inner district, the cost being L, equals the cost of conductors for one square; then next the central square consists of eight squares, and the cost is 8 L, and that gives us L pounds per square of houses. In the second district you will find on calculating it out that it is 2·5 L per square; in the third district it is 3·8 L; in the fourth, 5·2 L. Now compare this with the single system of tree mains, taking Mr. Kapp's data. The first district comes out on an assumption of 200 lamps to the square at £8,000. But look at the second, third, and fourth districts. In this table you see the comparative cost with and without feeders:—

	No. of Squares.	Cost.	Cost Without Feeders.	No. of Lamps.
		£	£	
1 district	8	8,000	8,000	1,600
2 districts	32	90,000	128,000	6,400
3 „	72	280,000	648,000	14,400
4 „	128	672,000	2,048,000	25,600

I will conclude with a very short reference to the network system; only a few remarks are required, because the network system is nothing more nor less than that which we have just investigated. There is simply this difference in it, that all the different squares may be connected together, the positive to the positive, and the negative to the negative mains. If all these squares were connected together, the positive mains and the negative mains of the different squares, we should have to choose our conductors exactly of the same size as we have chosen them here, and should have exactly the same conditions. If our conductors were chosen of the proper size for the current flowing, then the current in that case would flow along exactly the same channels as under the system I have been describing; the connections between the squares would have absolutely no effect. That would be the case when we had the maximum number of lamps on. It may be, however, that when the distribution is varying in different parts of the district it may be an advantage to have these different squares connected, and it may also have this effect that when anything went wrong with a feeder it then would not put a district into total darkness, because that district would be partially lighted with the other feeders. That could be avoided by making each feeder double, because it is very unlikely that two feeders would be injured at the same time. The difficulty in designing the network system up to the present time has been where to put the distributing boxes. Mr. Edison—and possiby others have followed in his lines—has drawn out plans for central stations without considering where to put the distributing boxes at all. This is putting the question in the wrong order; it should be first where to put the distributing stations, and what the size of the conductor; then our network system builds itself up in proper form and dimensions. I need hardly say, if we are to act upon economical principles, and have a variation of potential of not more than 4 per cent., we must have our distributing boxes exactly the same here as in the independent wire system.

We have then arrived at three very important results: first, we must have a large number of distributing boxes, and these distributing boxes must be nearer to the station than any of the lamps fed by them; the distance of the most distant lamp from a distributing box must not be over 124 yards; and the proportionate section of the conductors in different parts of the district must be the same as if we had independent wires coming from every lamp in the district to the central station. Now, when I have used the expression of 124 yards, you must not for a moment consider that as binding; this, as well as the economical size of conductor and the percentage of variation allowable, is dependent upon local circumstances.

MATHER AND PLATT'S PATENT DYNAMO GEAR.

THE object of this invention is for driving dynamos on board ship, and in other cases where the space is confined, and the first sketch shows an arrangement for driving a dynamo by helical wheel gearing.

The engine is one of Mather and Platt's usual double cylinder diagonal engines with cylinders 8 in. diameter by 10 in. stroke. As will be seen, the bed is of a rigid form and suitable for running at a high speed with great steadiness. The crank is of the ordinary double sweep form, and the cross head and slides are cylindrical. The engine is fitted with the well known Mather and Platt patent metallic piston. The valves are of the slide-valve type, and the engine is regulated by a Pickering governor attached to the steam supply pipe, and driven from the crank shaft by a pair of bevel wheels. The engine has long brass bearings, the crank shaft bearing on the driving side being made extra long.

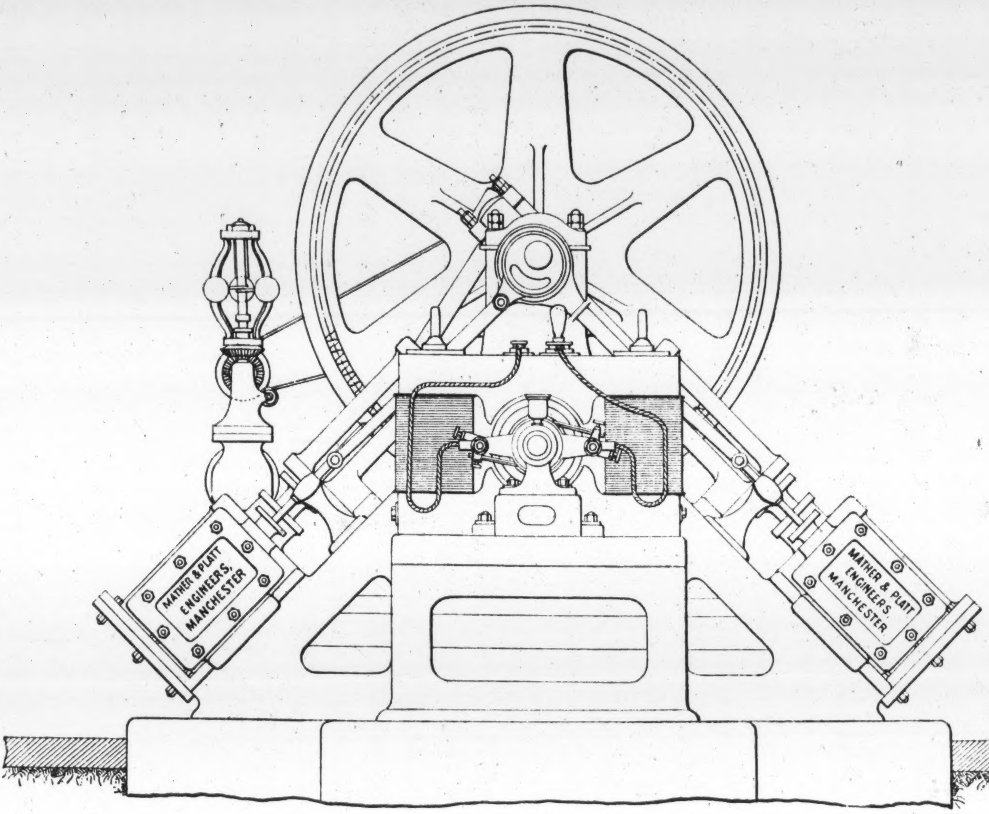
The fly wheel is formed into an internal spur wheel with double helical teeth, the boss of the wheel being turned and let into the crank shaft bearing which is bored out to receive it. By this means the strain on the crank shaft is one of torsion only, and the wheels are more rigid and kept in their proper relative positions so that the teeth are always in full gear. This wheel gears with a pinion keyed on a shaft carried through the engine bed. This shaft is coupled direct to the dynamo shaft by means of a flexible coupling. It will thus be seen that any slight irregularity or jar in the engine or first pair of wheels is lost in the shaft and coupling before reaching the revolving armature of the dynamo, which is of the greatest importance on account of its weight and speed and from the fact that any springing of the shaft, however small, is intensified by the unequal magnetic stresses which are at once brought into action. The wheels of the engine and dynamo are in the proportion of six to one, the former making 175 revolutions per minute.

This method of driving possesses great and obvious advantages over any kind of friction gear. All devices for driving by friction gear necessitate more or less delicate and elaborate arrangements for regulating the pressure between the friction surface, and these require constant attention and adjustment in order to follow up the wear. There is also the loss of power in friction, which even with plane surfaces is very considerable, and still greater when V grooves are employed. In an internal wheel the friction is less than in ordinary spur gearing, as the stresses are more nearly exactly tangential to the pitch line of the wheels. There is very little wear in the wheels and no parts requiring replacement, which is necessarily the case with the friction pinion. When the wheels are once set they require no further adjustment or attention. By using double helical teeth, in connection with an internal wheel, the number of teeth in gear at any instant is increased so that a finer pitch can be used, which reduces the noise so as to be almost unnoticeable.

The engine is shown in the drawing driving one of Mather and Platt's new compound-wound dynamos for 150—200 20-candle power lamps 100 volts E.M.F., at 1,050 revolutions per minute.

The same system of driving can be used with Mather and Platt's single cylinder oblique engines; the cylinder is 10 in. diameter by 12 in. stroke. The wheels are the same proportion as before, viz., six to one, and the engine makes 175 revolutions per minute. The crank shaft is of the best hammered scrap, and carried in long adjustable brass

Fig. 1.



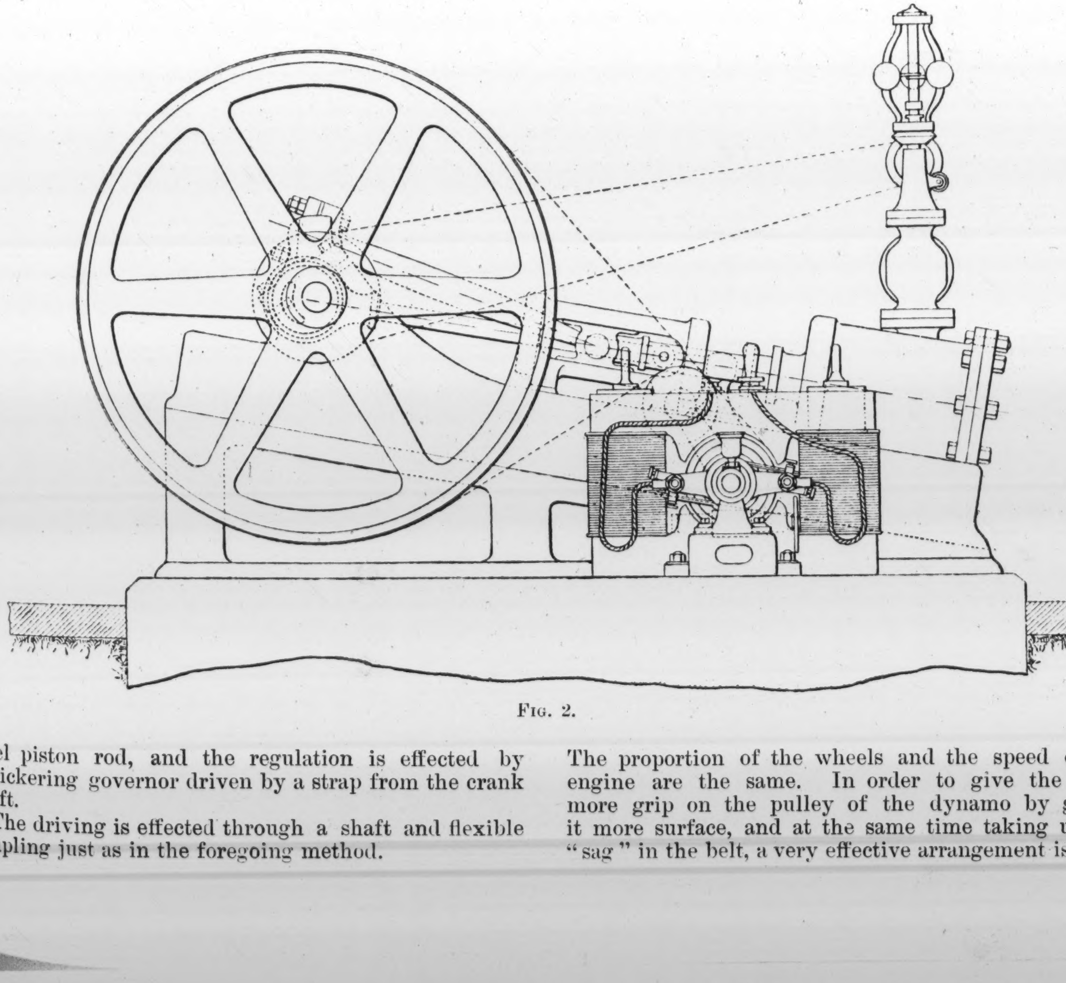


Fig. 2.

bearings. The connecting rod is also of wrought iron, having adjustable brasses at both ends and connected to the cross-head by a steel pin. The slide is of cast iron and bored to suit the circular cross-head. The engine is fitted with a Mather and Platt patent piston with steel piston rod, and the regulation is effected by a Pickering governor driven by a strap from the crank shaft.

The driving is effected through a shaft and flexible coupling just as in the foregoing method.

An arrangement of short belt driving may be applied to the same dynamo and diagonal engine above described. The engine is just as before, except that in the place of the helical wheel on the engine the fly wheel is turned suitable for belt driving. The proportion of the wheels and the speed of the engine are the same. In order to give the strap more grip on the pulley of the dynamo by giving it more surface, and at the same time taking up the "sag" in the belt, a very effective arrangement is used.

This consists of an arm which swivels on the filbore of the dynamo shaft and at the end carries a pulley riding loose on a stud. The lower end of the arm is formed into a wheel quadrant, which gears into a worm carried on a spindle at the end of the bed of the dynamo. By turning a hand wheel, keyed on the end of the worm spindle, the arm, and with it the pulley, is raised or lowered, and thus the strap, wrapped less or more round the pulley, as required, giving a neat and effective strap driving in a small space. It is evident that a long strap is unnecessary, and it is obvious that a great saving is effected in belting alone. For in this case we have a belt which may be less than half the length of a belt as generally used doing the same work, but with the advantage of putting less strain on the driving side of the strap, and also on the dynamo shaft by giving more pulley surface to the belt.

The second drawing shows the above arrangement of belt driving applied to the same dynamo, but using the single cylinder engine before described in place of the diagonal engine.

The advantages of these methods of driving are not confined to ship lighting. In mills and workshops it is often desirable to place the dynamo in the engine room, so that it may require no further attendance than from the man in charge of the main engines. The space is usually in such cases very confined, excluding the possibility of driving by a long belt. The method last described has been very effectively employed by Messrs. Mather and Platt in the installation in connection with the Theatre Royal and Comedy Theatre in Manchester for driving two 250-lamp Edison-Hopkinson dynamos. It may also be advantageously used with gas engines for house lighting, as it enables the engine and dynamo to be fixed on a single bed plate.

LEGAL.

The United Telephone Co., Limited v. Sharples.—High Court of Justice, Chancery Division. Before Mr. Justice Kay. This was an action brought by the United Telephone Company, Limited, against G. Sharples, of Fishergate, Preston, electrician, for damages for an infringement of the letters patent granted to Thomas Alva Edison on the 30th July, 1877, and vested in the plaintiffs; also for an infringement of the patent granted to Wm. Morgan Brown on the 9th December, 1876, now vested in the plaintiffs (this latter was a separate action, but the merits being the same the two cases were taken together), and for an injunction to restrain the defendant from manufacturing, selling, or letting on hire, the apparatus in question. The defendant denied the infringement, contending that the instruments were imported for the purpose of experiment which did not constitute a "user."

After the evidence on both sides had been heard, and the counsel for the defendant had addressed the Court, the plaintiffs not being called upon to reply,

Mr. Justice Kay said it had been proved that correspondence between Mr. Sharples and an American Telephone Company carrying on business at Rotterdam had taken place. Mr. Sharples, junior, in the witness box admitted that, at the time this correspondence took place, he knew the articles to which it related were infringements, and that they were such articles as could not be sold, used or made without infringing the patents of the plaintiffs. One letter, on the 21st March, written by the American Company, was significant: "We particularly wish to have all accounts settled as on the instant we open a new set of books which will be inspected by the inspector of the United Telephone Company; the old books will not be open to the inspection of the company." He, the learned judge, had seldom heard such evidence as had been brought before him in that case. The writer of the letters in evidence—the defendant's son and manager—had been into the witness box, and said with the utmost possible coolness that they never, in the least, intended to export there telephones or transmitters. They never had any export orders. The whole thing was to blind the American firm or anybody who might see the letters in order to escape the danger of infringement, because, said that ingenious young gentleman, "we were then under the belief that if we did export these things that would not be an infringement of the patents," and he also said they were never exported or sold to anyone. He (the learned judge) declined to be imposed upon by a tissue of miserable falsehoods.

The order he made was that there be a perpetual injunction against the defendant Sharples restraining him from an infringement of those patents, and, further, that he pay the costs. Judgment for plaintiffs with costs.

NOTES.

To Our Subscribers.—It is particularly requested that in sending subscriptions by postal orders from countries (such as Belgium, Italy, Norway, Denmark, and India) from which the *postal authorities* transmit the order, a letter of advice be always sent us direct; otherwise we are prevented from ascertaining, and crediting the amounts to, the senders.

Dr. Edward Davy.—We much regret to have to announce the death of Dr. Edward Davy, which took place at Malmsbury, Victoria, on the 28th January. The claims which this philosopher had to be considered as one of the pioneers of the electric telegraph were, as our readers are aware, prominently and conclusively brought forward by Mr. J. Fahie.

Electric Motors for the New York Elevated Railroads.—Mr. Magnus Volk has applied through his counsel, Charles Bulkley Hubbell, of New York, to be admitted to the association of inventors and owners of electric motors who propose to test their inventions in connection with the elevated railway system in America. Mr. Volk is confident that the electric motor can be applied to the elevated railway system with safety and profit.

The Electric Light at Colchester.—The report of the committee appointed at the last general meeting of the South Eastern Brush Electric Light Company to inquire into the present position of the company, will be found amongst our City Notes. From this, upon which we shall comment more fully in our next, it appears that the electric lighting experiment which has been carried on for some time in the town of Colchester has turned out an utter failure. This causes us no surprise, for we have on several occasions remarked that any other result could scarcely be expected from an installation in which the number of lamps probably never amounted to 500, whilst less than 2,000 cannot pay. The lamps used never, apparently, illuminated any other portion of the buildings supplied than the shops, the rate of supply, one halfpenny per lamp (of doubtful candle-power) per hour not being sufficiently tempting to induce householders to adopt an inefficient light for private purposes. We are also afraid that the Colchester work was carried out without any careful estimates being first compiled. The charging machines employed do not strike us as being the best that could have been obtained, and the secondary batteries, perhaps carelessly handled, and with too much complicated apparatus employed therewith, appear to have acted very indifferently. Although this result was not unexpected, we are very sorry that such a failure should be chronicled in our columns, for at the present time it will assuredly negative to a certain degree the endeavours of those who have so persistently approached Mr. Chamberlain with a view to the repeal or amendment of the Electric Lighting Act. Nevertheless, from the experience gained at Colchester much may be learnt and many serious errors avoided in future operations of the kind.

Electric Lighting on the Mersey Light Ships.—We learn that Messrs. R. E. Crompton & Co. are carrying out experiments, under the direction of Captain Graham Hills, R.N., of the Mersey Harbour Board, to test the suitability of the electric light for use on board the light ships. The set of plant for each light ship will consist of a Crompton-Bürgin dynamo, driven direct by a Willans engine, supplying current to two powerful arc lights of 4,000-candle power each. The lamps themselves will be of the ordinary Crompton-Crabb pattern, and will be fixed in the large lanterns at present in use. The beam will be diffused equally in all directions without any attempt to concentrate it by means of dioptric appliances. The whole of the generating plant is contained in a small deck house, and can be managed by the ordinary lightship keepers.

Electric Light v. Dynamite.—The elaborate precautions which the authorities have decided to take for the protection of the Houses of Parliament against any further attempt on the part of the dynamitards include the constant watching, by day and night, of the Palace from the river. At the invitation of the Commissioners of Police an interesting series of experiments was conducted on Monday night under the direction of Mr. I. Spielmann, with a view to ascertain the applicability of the electric light generated by the Skrivanow battery to the service required. When the battery was attached to an arc lamp of 600 candles nominal a beam of light was thrown from the police steam-launch, which had taken up its station on the opposite side of the river, on to the terrace sufficiently strong to enable the occupants of the boat to follow the movements of a constable found to be on duty there, and to detect the presence of a small wherry drifting close by the river wall. From a distance of thirty yards, or thereabouts, the blinking features of a persecuted policeman were distinctly visible, while every outline of the floral masonry was seen as clearly as in the daytime. The police officials were much gratified at the result of the experiments.

The Electric Light on Board a Yacht.—The new yacht *Retriever*, belonging to Mr. O. Randall, has just been fitted throughout with the electric light by Mr. F. Geere Howard. The saloons, cabins, and engine room are lighted by incandescent lamps of 20-candle power each, distributed as follows :—Six in the saloon, three in the chart room, one in each of the cabins and passages. The engine room and passages are fitted with portable lamps, so that any part of the vessel can be lighted at will. An arc lamp of 3,000-candle power, fitted with all the most recent improvements, is arranged for use as a search light. Both the search light and the incandescent lights are arranged in parallel arc, the current being supplied by one of the Crompton compound type of dynamos, driven direct by a Tower spherical engine. The engine and dynamo are fixed upon the same bed plate, which only occupies a space of 4 ft. by 2 ft. 7 in. by 18 in.

Electric Lighting in New York.—The *Electrical World* states that there are over 26,000 incandescent lamps burning regularly in New York, and that wires have been run for at least 6,000 more. There are also more than 2,700 arc lamps in use.

Electric Lighting at Chicago.—The annual report of the electric light inspector to the superintendent of Chicago city telegraphs shows that there has been a very large increase in the number of electric light plants during the year, both arc and incandescent. One life only has been sacrificed in the city, and the peculiar circumstances of that occurrence seem to throw a shadow of uncertainty on the cause of the death. Unfortunately the deceased was alone in the engine room at the time, and when found was lying upon his face, at least 12 feet from the back of the dynamo, with a shovel at his side. He had been at work with the shovel just before supper, and finishing before the rest of the employés, had returned to his work alone. As he was a new man at the business he had been repeatedly warned of the necessity of the utmost caution in handling the lamps and dynamo, and circumstances show that if he did come to his death by means of a current of electricity it is quite certain that the accident arose from disregard of the frequent warnings he had received. *Per contra*, between May and November 12 deaths are recorded from improper handling of gas.

Gas v. Electricity.—At the last meeting of the Port Glasgow Town Council, the Provost urged a reduction in the price of their gas so that they might keep the hold of their large consumers. They knew that they had a great amount of difficulty in keeping these consumers lately, as many of them were inclined to go in for electric lighting.

Lighting of a Laundry.—The laundry at Harrow School has for some time been lighted by means of two A Gramme machines and Serrin lamps ; this installation has now been replaced by a Crompton-Bürgin machine and incandescent lamps.

Electric Lighting in Theatres.—On the occasion of the International Electrical Exhibition at Munich a temporary stage was specially erected at the instance of Baron von Perfall, General Intendant, which was experimentally lighted by electricity in the presence of the managers and directors of the German Theatres. This trial, as well as the experiments made by the German Edison Company during nine months at the Royal Residence Theatre, induced the directors of the Royal Court Theatre to entrust the illumination of both theatres to the German Edison Company of Berlin. This new installation is, with the exception of the new electric central stations now in course of erection in Berlin, the largest of its kind in Germany. The machinery by which the current is generated consists of six large Edison dynamo machines, five of which are each capable of lighting 450 Edison lamps of 16-candle power each, whilst the sixth machine is capable of feeding 250 similar lamps. The latter is chiefly used for lighting purposes during the day. The motive power is supplied by three high-speed compound steam engines, together of about 350-H.P., and specially constructed for electric lighting. A number of different optical and acoustical controlling apparatus indicate at all times to the attendants the number of lighted lamps, the quantity of electricity supplied by each machine, the intensity of the light emitted by the lamps in the theatre, any faults which may have been caused by damage to the wires, &c. The cables are of 315 square millimetre cross section, and are first surrounded with a thick layer of some insulating material, then with a covering of lead, again with a serving of tarred jute, further protected with thick iron wires, and finally with a layer of asphalte. The cables are laid underground at a depth of 1 metre. In the theatres the current is distributed through 2,500 Edison lamps of 16-candle power each ; numerous shunt arrangements are made in order to prevent the heating of the conducting wires. Inside both theatres there are numerous regulating apparatus, which allow of the lamps being gradually or suddenly extinguished or relighted in smaller or greater groups. A rheostat of German silver wire regulates the supply of the current necessary for the degree of light required. The principal regulating apparatus of the Court Theatre is underneath the stage next to the prompter's box. The attendant in charge of the apparatus can overlook the stage from his place, and so observe the effect of his manipulations. For the effective lighting of transparent scenes, &c., the arc light can be substituted behind the scenes direct, without any separate electric machinery being required. The extensive and complicated work of installation was rendered all the more difficult, as it had to be carried out without in the least disturbing the performances at the theatres. We may mention here that on the Continent the theatres at Brünn, Prague, Stüttgart, the Scala, and the Manzoni at Milan, are completely lighted by the Edison glow lamps ; and that the installations of the electric light in both Royal Theatres at Berlin have just been taken in hand by the German Edison Company.

The Electric Light at Queen Street Station, Glasgow.—For about four years the terminus of the North British Railway, at Queen Street, Glasgow, has been lighted by electric light. The installation consists of two 10-horse power nominal horizontal engines, and one boiler, of five dynamo machines, seven arc lamps and 50 incandescent lamps. The engines and boiler were manufactured by Marshall Sons & Co., of Gainsborough, and have been found to give most satisfactory results. The engines are fitted with Hartnell's patent automatic expansion gear, which enables the steam to be cut off at any point throughout a large range of the stroke, and thus provides for sudden variations of work, either increasing or decreasing. It has been proved by actual experiment with these engines, that with a sudden variation of fully 80 per cent. in the load, the speed does not vary more than 1 per cent., and that only for an instant, the engine answering immediately to the change of conditions. The dynamo machines have stood the test of long working in a satisfactory manner, only one of them having been overhauled after three years' working, and the whole having cost, during last years' working, only a trifling sum for repairs. Three of the lights in the station are run on single circuits from Gramme machines of the type "A," popularly known as the workshop Gramme. The remaining four arc lamps are run from a "Burgin" machine. It runs at a speed of 1,300 revolutions per minute, and gives about 18 to 20 ampères current, with an E.M.F. of about 200 volts. The arc lamps are of Crompton's original clockwork pattern. The incandescent lamps are of Swan's make, and were the first to be fitted up on permanent work in Scotland. These lamps have been working on an ordinary direct-wound machine of about 90 volts potential; the lamps are run in two rows of 25 each. The average life of the lamps has been found to be about 600 hours. This is somewhat below the usual performance of these lamps, and is probably due partly to the fact of their being used on a machine which does not "regulate," and partly to the fact of their being run two in series. This arrangement was rendered necessary by the circumstances at the time the work was done. The North British Company has in its possession two 20 candle-power lamps which have had the extraordinary longevity of over 3,000 working hours. The installation was originally carried out for Mr. R. E. Crompton by Mr. Henry A. Mavor (now Muir and Mavor, 140, Douglas Street, Glasgow). It may be interesting to know the cost to the railway company of the lighting of the station and goods yard by the plant above described. The cost of the arc lamps is found to be as follows:—Running four lamps 2,000 candle-power nominal, running three lamps 3,000 candle-power nominal, including coal, water, oil, waste and repairs to the whole plant, also all carbons and wages of attendants with 10 per cent. per annum for interest and depreciation: average cost per lamp sixpence per hour. Running 50 incandescent lamps, including all charges as above and renewals of lamps: average ·14 pence per hour per lamp.

Electric Lighting at the Society of Arts.—We mentioned some time back that accumulators were being tried at the above institution in connection with the existing electric lighting. These were put in as regulators, but on more than one occasion they have supplied the current for all the lamps in the lecture room throughout the evening. The result has been considered by the council so satisfactory that the Electrical Power Storage Company has received an order to fix permanently a set of the latest type of cells.

Electric Lighting of Private Houses in Paris.—The first installation in Paris for supplying private houses with electricity is now working. It has been placed in the Passage des Panoramas, Galerie Vivienne, for the use of all the houses in that extensive block, but only a small number of lamps are yet in use.

Bell's Patent in Canada.—On the 24th ult. the the Hon. J. H. Pope, the Canadian Minister of Agriculture and Commissioner of Patents, rendered decision *in re* the Toronto Telephone Company *v.* the Bell Telephone Company of Canada. The case was one of dispute against the Bell patent of August 22nd, 1877, for alleged forfeiture, on the ground of non-manufacturing and of importing. Mr. Pope declared, upon the grounds raised, that the patent (No. 7,789) had become null and void.

Telephony in Queensland.—The telephone was established in Queensland in October, 1880; in 1883 there were four exchanges and 352 subscribers.

Use for the Telephone in Agricultural Districts.—The use of the telephone in agriculture is being tried in France. A large landowner in the Department of the Loire has established a regular circle of telephonic communication throughout the whole of his estates, using the largest trees as stations, and thus simultaneously direct operations in all parts of his domain.

The Russian Government and the Telephone.—The Russian Government has resolved to make an attempt to establish and work the telephone on its own account. Hitherto systems have been worked entirely by private companies. The first official experiment is to be made at Kieff. Other towns will be supplied if 50 persons subscribe half of the yearly payment in advance. The subscriptions will not exceed 250 roubles a year for three versts of wire, with 50 roubles additional for every extra verst. Absolute official power will, of course, be reserved over the telephones as in the case of the telegraphs.

Telegraphy in Queensland.—The officers of the Post and Telegraph Department of Queensland sent their Christmas greetings and best wishes for the New Year to their colleagues on a tastefully-designed four-page card. From the statistics and other information given therein we learn that the number of telegraph offices has increased from 7 in 1861, to 201 in 1883; the revenue from the use of the telegraph in those years being £938 in 1860 and £70,583 in 1883.

Telegraph Revenue.—The receipts from April 1st, 1884, to February 7th, 1885, were £1,490,000; against £1,485,000 from April 1st, 1883, to February 9th, 1884.

The Ball Unipolar Inductor Machine.—On the 14th January Mr. C. W. Raymond read a paper before the New York Electrical Society descriptive of the above machine. This dynamo has so often figured in our own pages that our readers should be quite familiar with its construction and admirable performance. There are, however, in Mr. Raymond's paper several points which, we think, will bear reproduction. The author says:—

"I wish to avail myself of the opportunity here offered of denying a statement made by an electrician prominent enough to be more careful in his *misstatement* of facts so liable to injure others; and for fear it may be thought I mean some one of the many who applauded the discourteous, certainly untruthful statement, I will say, I allude to the report of the remarks made by Prof. Silvanus P. Thompson, before the National Conference of Electricians at Philadelphia, as printed in the ELECTRICAL REVIEW (London) December 13th, 1884. After calling attention to the 'bad design' of the machine, and admitting with much condescension that 'it *may* work,' because 'it is hard to have a dynamo machine with a Gramme ring in it that does not work,' the professor goes on to say that the lines of force 'spread out into the air': 'I examined this machine once in England' (probably just as he examined it here), 'and I saw a similar machine in your exhibition'; and, as a proof of his statements, adds: 'It seemed to me to be a striking commentary on the omission of the pole piece that over that machine *alone* of all machines in the Exhibition, there was a sign which ran: "'*Do not approach this dynamo for fear of magnetising your watches.*'" ('Laughter and applause.')"

"The truth is this: at the beginning of the Exhibition the management warned the public against dynamos, by tacking up or suspending over each dynamo stand a card saying: 'Dynamos will magnetise watches. Keep away.' In a very short time the only cards allowed to remain was one over the 'Edison' (which the professor evidently did not see), and one over the Ball dynamo. I may also say there was an establishment close to the entrance to the Exhibition which advertised to take charge of watches of visitors, *probably for fear of being damaged by the Ball dynamo.*

"This may seem a trifling matter; so it would be were it the only instance of a deep-rooted prejudice, or unscientific ignorance of facts which has been published several times against the Ball dynamo, in addition to similar remarks at its expense made at this conference of scientific men. Contrast the remarks of this distinguished English scientist with the manly tone of Prof. Nipher, who virtually replied to Prof. Thompson: 'It occurs to me to say a few words in regard to an unfortunate machine which has been referred to several times, and which I saw the other day for the first time. It has two armatures and only two pole pieces. I was as much astonished as anybody could be when I saw it, but when I was informed that it weighed less than one thousand pounds, and maintained a high strength of current, I thought it worth while to investigate what the machine would do before we said too much about how it worked.' . . . .

"I also remember a little incident which occurred two years ago, when I represented this machine in London. I received a visit from Mr. Latimer Clark, an eminent English electrical engineer. Almost his first words to me were: 'Mr. Raymond, I don't like the looks of that machine; it is built wrong, constructed upon entirely wrong principles, and I would almost be willing to stake my reputation that it won't work.' I said nothing, but allowed him plenty of time to examine the dynamo. When I started the machine and closed the circuit the machine was doing its best, and the six fully 2,000-C.P. arcs lit up the shop, the gentleman was startled; he looked first up at the lamps, then at the dynamo; after a little he put his hand on his head and said: 'I am vexed, very much vexed.' 'Why?' I asked. 'Because,' said he, 'all my experience and practice of the past thirty years teaches me that that machine is built wrong, wound wrong, ought not to and cannot work, but, confound it, it does, and very nicely, too!' Mr. Clark to-day is one of the few prominent English electricians who admits the good qualities in the Ball dynamo, and I trust he will pardon me for telling tales out of school."

Endurance Tests for Dynamos.—Although the Edison-Hopkinson dynamo is the only one which can at present be said to have a public record of a fortnight's continuous run, we have no reason to doubt but that this record could be equalled, if not surpassed, by several others. We understand that "Victoria" dynamos have been used for a great number of hours continuously, and with a success which leads the constructors of these machines to the belief that they could be run for very lengthy periods without deterioration if any particular object could be thereby obtained.

Improvements in Carbons.—It is stated that M. Carré, the well-known carbon manufacturer, of Paris, has taken out patents for improvements in carbons, which are manufactured by Emile Levy, of Paris.

The Soudan Expedition.--The preparations for the despatch of the air-line section of the Telegraph Battalion Royal Engineers are rapidly proceeding. The engineers will take out many miles of wire, besides poles and the usual telegraphic apparatus. Major H. F. Turner and Lieut. H. E. M. Lindsay, R.E., have been ordered to Aldershot from Bristol, which is the headquarters of the Second Division Telegraph Battalion, to go out with the air-line section.

Electric Locomotion in America.—Exchanges state that preparations are being made to experiment with the electric motor in running cars across the East River Bridge. The Daft electric company having the matter in hand has already deposited rails and other materials with which to begin building the road, and it is expected that before spring the line will be in operation. A movement is in progress to introduce the experiment on the Second Avenue elevated road.

The Dangers of High Tension Currents.—M. Hospitalier writes the following in *l'Electricien*:—"The use of currents of high tension offers, as is more or less admitted by everyone, obstacles and dangers which delay their industrial application. Alluding, at present, to the dangers only, we think it right to remind our readers that they appear to be admitted as real even by the most pronounced advocates of the high tension currents. In October, 1883, M. Joseph Bertrand, perpetual secretary of the Academy of Sciences, wrote in the *Revue des deux Mondes*, as follows: 'In a large machine everything, even the danger which we must face, is large; the dangers are foreseen, we must know how to neutralise them. Let the E.M.F. be 7,500 volts, it will be certain death to whoever touches the conductors; everyone must be warned. Is it safer to live amongst mechanical wheelwork?' . . . It is quite natural that we have sought to eliminate those dangers, and, whilst we are awaiting the publication of the proceedings of M. Marcel Deprez, Dr. d'Arsonval has, in a note* read before the *Academie des Sciences*, at its meeting of the 26th of January, 1885, indicated from his point of view, in what manner the problem may be solved. M. d'Arsonval states that, in general, the accidents which have occurred up to the present time did not take place whilst the electric current had a permanent existence, but at the moment of the breaking or of the making of the circuit. That is a statement which does not appear to be borne out by facts. As a case in point, we cite the fatal accident which occurred recently in England at the Health Exhibition with a high tension Hochhausen machine *without interrupting the circuit*. It is, then, a perfectly established fact that a great difference of *permanent* potential, that is to say, such as not to be perceptibly lowered by the discharge through the human body, is capable of causing death. This does not in any way affect the exactness of the propositions laid down by M. d'Arsonval in the note quoted above, but we wish to show clearly that those propositions do not apply to the current whilst actually flowing, but to the moment of its interruption. The self-induction of a circuit setting up, at the moment of the interruption of the current, an E.M.F. of self-induction of short duration and of far higher tension than the initial E.M.F. which maintained the current, any arrangement capable of absorbing or diminishing that E.M.F. will undoubtedly lessen the danger, and we are glad to admit that the shunt-voltameters may be capable of neutralising the effect of the extra current. But this result, whose usefulness and importance we are pleased to recognise, does not in the least diminish the danger of the contact by the human body between two points of a circuit whose difference of potential is great. It will therefore be useful to seek to determine experimentally the limits beyond which the tension would become dangerous in practice; the subject is not, however, adapted for direct experiment, and if we can succeed in determining those limits, it will be judicious to apply the means recommended by M. d'Arsonval for preventing the extra current, set up by the interruption of the circuit, from exceeding them."

Lighthouse Illuminants.—On Tuesday night Dr. Ball, the Astronomer Royal for Ireland, with the Commissioners of Irish Lighthouses, arrived at Dover, and proceeded to the South Foreland experimental lighthouses and made a general inspection of the works. During the night a dense fog sprang up in the Channel and enabled the Commissioners to make some very valuable experiments with the lights, which will greatly influence the decision of the authorities on the relative values of gas, oil, and electricity as illuminants for lighthouses. The experiments will in all probability terminate shortly.

Electrical Engineers' Catalogue.—A neatly-arranged and well-printed catalogue and price list of dynamos, batteries, motors, engines, &c., has reached us from Messrs. Cordner, Allen & Co.

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* See our other columns.—EDS. ELEC. REV.

Photographing the Larynx.—Dr. Theodore Stein has devised an ingenious and simple apparatus for taking photographs of the larynx which is likely to be useful in medicine and pathology, since it will enable doctors to study from day to day the changes of laryngeal disorders. It consists of a small incandescence lamp of 10 candle-power, fed by a portable battery, and cooled by Nitze's system of circulating water. This supplies the light which illuminates the throat and larynx. An image of the latter caught on a small mirror is received into a small camera on gelatine-bromide plates, the exposure being regulated by an electro-magnetic device operated by pressing a button.

Fatal Accident to an Electric Light Employé.—The annual dinner of the employés at the Chelmsford Electric Light Works, at the Corn Exchange, Chelmsford, last Saturday evening, was attended by a shocking accident. About an hour after the company had dispersed, the hall-keeper went into the cellar for the purpose of turning off the gas, and found a man named Edwards, who was employed at the Electric Works, lying at the bottom of the steps quite dead, his skull being fractured.

Barney v. United Telephone Company.—On Friday last week Mr. Justice Chitty refused to grant an injunction asked for by Mr. Barney to restrain the United Telephone Company from publishing that the Boult telephone patent, No. 11,363, of 1884, was an infringement of its patent rights. The ground stated by Mr. Justice Chitty for his refusal was that under the 32nd section of the New Patent Act of 1883 the person who considers himself aggrieved by such a publication must establish the fact that his instruments are not infringements of the patent rights of the U. T. Co. before he can obtain an injunction for damages. The costs of the motion to abide the trial of the action, when the question of infringements will be tried.

Personal.—Messrs. R. E. Crompton & Co. have taken into partnership Mr. J. F. Allbright, who was till lately engineer to the Edison and Swan United Electric Light Company.

Messrs. Latimer Clark, Muirhead and Co., Limited.—This firm announces that in addition to its business as telegraph and electrical engineers, manufacturers, and contractors, it has taken that of general engineering.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Single Wire Multiple Telephone Signal Co., Limited.—The annual return of this company, made up to the 29th ult., was filed on the 3rd inst. The capital is £5,000 in £10 shares. 194 shares have been taken up, and the full amount has been called and paid thereon. Since the last return 10 shares have been taken up. Registered office, 11, Old Broad Street.

Swan United Electric Light Company, Limited.—The annual return of this company, made up to the 9th December, was filed on the 7th inst. The nominal capital is £1,000,000 in 200,000 shares of £5 each. 99,900 shares have been issued, of which 19,750 are fully paid, and upon the remaining 80,150 shares £3 per share has been called. The total of the calls paid is £338,022, leaving £1,178 unpaid. As compared with the return made up to the 11th December, 1883 (which was also filed on the 7th inst.), the paid up capital shows an increase of £38,902. Registered office, 57, Holborn Viaduct.

Primary Battery Company, Limited.—The statutory return of this company, made up to the 19th ult., was filed on the 22nd ult. The nominal capital is £6,300 in £5 shares, the whole of which have been taken up, and the full amount has been paid thereon. Registered office, 12, Princes Street, Hanover Square.

A special general meeting of the members of the company was held on the 5th ult., at 15, York Buildings, Adelphi, when it was resolved that the capital of the company be increased to £13,000 in £5 shares, the additional capital to be used for purchasing interests in primary and secondary batteries, or in such other manner as the directors may deem best to serve the company's interest. The resolution was confirmed at a meeting held at the offices on 20th ult., and was duly filed on the 29th ult.

The company has entered into an agreement, dated 23rd ult., for the purchase from Mr. Farnham Maxwell Lyte, of Putney, of the whole of his patents now in force relating to the manufacture and working of primary and secondary batteries, and all his future inventions in connection with such batteries, or of any method, apparatus, or instrument in connection with the production or generation of electricity. The purchase consideration is £500 in fully paid shares.

CITY NOTES, REPORTS, MEETINGS, &c.

The Submarine Telegraph Company, Limited.

THE report of the directors says :—The annexed accounts for the six months ending 31st December, 1884, show a result which enables the directors to add £8,026 0s. 5½d. to the reserve fund, and to recommend a dividend at the rate of 14 per cent. per annum, and to carry forward a balance of £377 18s.

The receipts for the six months are less than those of the corresponding period of 1883 by £682 0s. 2½d. This reduction is due partly to the shorter length of the messages transmitted, and partly to the receipts from the wire leased to the Indo-European Telegraph Company not having been so large as in 1883. But on the other hand there has been a small increase in the sum paid by the French newspapers which lease special wires during the night for their correspondence.

The number of messages transmitted in the half-year has been 1,428,520, containing 17,007,776 words, showing an increase of 31,886 messages, but a falling off of 219,012 words transmitted in the six months ending 31st December, 1884. The average length of the messages in 1884 was 11·91 words against 12·33 words in 1883.

The expenses for the half-year against the joint account have been £1,969 14s. 2d. more than in 1883, arising partly from an increase in the cost of repairing the cables and the company's steamer, and in law charges ; and partly from the increased pay to the telegraph clerks and others in the employment of the company, and the increased sum the company has now to pay to the French Administration for working the circuits between the French coast stations and London.

It has been necessary to place new cylinders in the steamer and to thoroughly overhaul and repair her. The cost of the cylinders and work in connection therewith has been £1,655 11s. 4d., which has been paid out of the fund in hand created for this purpose by the usual fixed half-yearly charge against revenue of £227 5s. 6d.

The expenses incurred in overhauling and repairing the steamer amounted to £627 14s. 5d., of which £209 4s. 10d. has been charged in the annexed accounts, and the remainder will be charged in the next three half-yearly accounts.

In the course of the half-year there has been inserted in the company's cables to Ostend and Dieppe two knots of new cable, but fortunately no expense has fallen upon the company in connection with the Government cables in the North Sea.

The new cable laid down by the Post Office to Holland, referred to in the last report, has been in good working order, but the other cable to Holland is now interrupted. It will be repaired, however, by the Post Office, at their own expense, and the authorities intend to insert in it a long length of new cable as soon as the weather is favourable for the work.

All the company's cables are at the present time in good working order.

Dundee and District Telephonic Company, Limited.

THE annual meeting of the Dundee and District Telephonic Company was held in Lamb's Hotel, Dundee, on the 4th inst., ex-Provost Moncur presiding. The report of the directors, which we have already published, was taken as read.

The Chairman said : In moving the adoption of the report I have to congratulate the shareholders and the public on the present position and future prospects of the company. Notwithstanding the powerful opposition with which we have had to contend, we have not only held our own, but made a fair amount of progress during the past year. Of course, a great increase in the number of our subscribers could not have been expected, seeing that the field had already been well occupied. However, the advance that has been made indicates that the business community value the telephonic facilities afforded by our company, and are resolved to stand by us in our efforts to supply such facilities at the cheapest possible rate. Not only has this company been the means of making Dundee the cheapest and best telephoned town in the kingdom, but it has helped our neighbours in Perth to get telephonic communication on very favourable terms. As stated in the report, we add £200 to the reserve fund, which now amounts to £800, and carry forward £180 16s. 4d., besides paying a dividend of 5 per cent. per annum to the shareholders. It is somewhat surprising that Glasgow, Edinburgh, and other large towns continue to pay such high rates for their telephonic communication, notwithstanding that it has been so clearly demonstrated in Dundee that they might have such facilities at a much cheaper rate. Even the Post Office authorities are prepared to supply telephones at a cheaper rate than that paid by the Glasgow people. A circular issued some time ago states that in order to meet the convenience of the public the Post Office will be prepared to provide for a system of telephonic communication in towns—the annual charge to be £14 10s. within half a mile and £18 within a mile of the centre. With such facts before them it is surprising that the Glasgow people should contentedly pay £20 per annum for their telephones. I have only further to say that the directors hope, by endeavouring to improve in every way their system and service, to merit a continuance and increase of that support which the local company has hitherto enjoyed.

Mr. James Murison seconded the motion, which was unanimously agreed to, and the report was therefore adopted and a dividend of 5 per cent delared.

Mr. Andrew Taylor moved that a sum of fifty guineas be awarded as remuneration to the directors for their services during the past year, which was unanimously agreed to.

Mr. Peter Mathew and Mr. A. R. C. Patterson were re-elected directors, Mr. Simpson was re-elected general manager, and Mr. John Miln was re-appointed auditor.

The South Eastern (Brush) Electric Light and Power Company, Limited.

LONDON, *9th February*, 1885.

THE committee appointed at the general meeting held on 22nd December last, to inquire into the present position of the company, beg to submit the following report to their fellow shareholders :—

The balance-sheet presented at the above meeting being only made up to 30th June, 1884, the committee requested Messrs. Price and Waterhouse, the auditors of the company, to prepare an approximate balance-sheet and report on the accounts for the half year ending 31st December last.

From these documents the committee have summarised the following figures, which will show approximately the present financial position of the company :—

DR.—To paid up capital, £40,615. CR.—By concessions, preliminary expenses and expenditure in obtaining provisional orders, £14,711 4s. 7d.; by Colchester installation and plant, £7,388 7s. 5d.; by stock and office furniture and office installation, £1,941 2s. 11d.; by sundry debtors, creditors, and bills, £263 19s, 5d.; by cash advanced to Consolidated Company against debentures and shares, £7,000 ; by interest due by ditto, £691 4s. 5d.; by losses on working to 31st December, 1884, £8,175 16s. 9d.; by cash at bankers and in hand at 31st December, £443 4s. 6d. Total, £40,615.

Of the total paid up capital of upwards of £40,000, therefore, practically nothing now remains but the breaking up value of the Colchester installation, the stock, furniture, and office installation, and the debentures and shares of the Consolidated Company.

COLCHESTER INSTALLATION.—The capital expenditure at Colchester amounts, as above stated, to £7,388 7s. 5d., and the results of the working of the installation since its inauguration are as follows :—

	£	s.	d.		£	s.	d.
Station expenses to June 30th, 1884	703	1	9	Receipts for same period	226	1	10
Do. to Dec. 31st, 1884	514	18	11	Do. do. ...	168	9	0
					£394	10	10
				Debit balance ...	823	9	10
	£1,218	0	8		£1,218	0	8

The installation has, therefore, already cost the company £823 9s. 10d. actual loss on working, without reckoning anything for depreciation of plant (a very large item), or interest on the capital sunk, which last item at 5 per cent. since June, 1883, would represent a further sum of over £600.

CONSOLIDATED COMPANY.—Under the agreements with the Consolidated Electric Company it would appear that the South Eastern and Provincial Companies are bound to make cash advances to that concern to the extent of £10,000 each. Of this sum this company and the Provincial have already paid each £7,500. The balance has recently been called up, and will doubtless have to be paid. For these cash advances the two companies hold debentures as well as one-fifth each of the nominal share capital of £100,000 (say £20,000 each). The Consolidated Company has been debited with the interest upon the debentures in the books of the South Eastern and Provincial Companies and the amounts carried into profit and loss as an asset. No actual payment to either company has in fact been made, as there are at present no ascertained profits of the Consolidated Company. The committee are informed by the board that the £15,000 received by the Consolidated Company is now wholly represented by patents acquired by that company, and by the plant and fittings of the factory in Cow Cross Street. As to the intrinsic value of these assets it is impossible for the committee to offer any opinion.

RECOMMENDATION OF COMMITTEE.—In view of the disastrous results so far, and the certainty that a continuance of the present policy must lead to the calling up of the whole of the unpaid capital, to be followed by the compulsory liquidation of the company at no distant date, the committee are unanimously of opinion that immediate steps should be taken for the purpose of trying to save what remains of the property of the company. In the opinion of your committee this can best be done by the voluntary liquidation of the company forthwith. The liquidators can make any arrangement which may be practicable with the Anglo-American Brush Corporation, and it will be their duty to divide the remaining assets of this company in as inexpensive and expeditious a manner as possible.

Your committee are glad to see that their recommendations are not to be opposed by the directors, as will appear by the following letter addressed to the solicitors of the committee :—

The South Eastern (Brush) Electric Light and Power
Company, Limited, 68a, Cow Cross Street,
London, E.C., *5th February*, 1885.

Messrs. Blewitt and Tyler,
79½, Gracechurch Street, E.C.

Dear Sirs,—The directors have to-day further considered the position of the company with reference to the views entertained by the committee represented by you, and they are prepared to concur with your committee in endeavouring to make such an arrangement with the Anglo-American Brush Corporation as will be satisfactory to the shareholders ; failing which the directors will not oppose any proposition which may be approved at the adjourned general meeting for either winding up the company voluntarily, or carrying it on at a minimum expense.—Yours faithfully,

The South Eastern (Brush) Electric Light and
Power Company, Limited,
GEO. OFFOR, *Manager*.

Your committee in no way coincide with that part of the above letter which suggests a future carrying on of the business.

In due course if necessary your proxies will be asked to give effect to the above recommendations, and your committee think the shareholders will have no hesitation in giving them, having regard to the above statements.

W. HEWETT, Jun., C. H. STEWART, A. L. RIDDELL.

Anglo-American Telegraph Company, Limited.

ON Friday afternoon last week the ordinary general half-yearly meeting of the proprietors of this company was held at the Cannon Street Hotel under the presidency of the Right Hon. Viscount Monck, chairman of the company. There was a fairly large attendance of shareholders ; the proceedings were characterised by a prevalent feeling of great excitement, amounting at times to positive uproar.

The Secretary, Mr. T. H. Wells, having read the notice convening the meeting, and the report and statement of accounts having been taken as read,

The Chairman moved the following resolution : That the report of the directors and statement of accounts to December 31st, 1884, now submitted to this meeting be and the same are hereby adopted, and that the following dividends, less income tax, be declared :—A first balance dividend of 17s. 6d. on the ordinary consolidated stock, making, with previous payments, 3½ per cent. on that stock for the year 1884 ; a balance dividend of £1 10s. on the prefered stock, making 6 per cent. for the year ; and a first and final dividend of 5s. on the deferred stock. In moving this resolution, he said in the first place he must congratulate the shareholders upon the fact that all their cables were in good condition. At the present moment there were four cables of the combined companies which were not at work, and the whole of the work, so far as the combination was concerned, was done through this company's cables. With reference to the accounts, there was a considerable increase in the expenditure as compared with the corresponding half year ; but this was chiefly due to the extraordinary and inevitable item of renewal of buildings, &c. The directors desired to keep the expenditure as low as possible, and the salaries at home and abroad showed a decrease of £538 11s. 4d. The revenue, he was sorry to say, was £12,136 less than that of the corresponding period of last year. That was due principally to the depression of trade, which still continued, on both sides of the Atlantic, for though the tariff was reduced on December 24th, 1884, to 1s. 8d. per word in consequence of the Mackay-Bennett rate, it was not conceivable that that reduction had had any appreciable effect on the half year's revenue. The real question before them was the important one of competition, which, for them, had begun at a very unfortunate period. Their competitors would, no doubt, be guided in their future course by the results of the operations they were now conducting. Given a certain number of cables, working with equal efficiency, each would take its fair proportion of the general traffic. The shareholders would naturally ask what they (the directors) proposed to do under the circumstances. (Hear, hear.) Well, he was afraid that at the present moment he could not give them any very satisfactory answer. It was obvious that there was very little use in approaching the Mackay-Bennett people with the view to an arrangement or compromise until those gentlemen had ascertained for themselves, by the operation of their traffic, what the future would probably be, and with respect to any other course he did not think it would be wise to speak at present. (Hear, hear, and oh, oh.) The directors, taking the best advice they could get, and watching anxiously the course of events, would take such action as they believed to be best for the interests of the company. He did not like to indulge in prophecy, but it struck him that the ultimate outcome of all these proceedings would not be as favourable to the telegraphing public as that public imagined, for there was an old adage to the effect that where combination was possible, competition was not likely to go on. For the present, however, no effective steps could be taken. There was another burning question—that of the renewal. He went into the matter very fully at the last meeting, and he would not weary them by repeating his arguments, but he should like to remark that the fact that at the present moment there were four cables disabled in the Atlantic ought to exercise a considerable influence upon the decision which the shareholders might come to on this matter. What had happened to these cables might happen to those of the Anglo-American Company; in point of fact, two of the broken ones were newer than those of this company. In his opinion it afforded a striking example of the insecurity of cable property and the absolute necessity of having the means in hand of renewing or repairing a cable that broke down. There was another question—that of the responsibility of the directors should they pay dividends to the neglect of making provision for proper maintenance. He believed that were the directors to do this, against their better judgment, they would be personally liable in the event of a shareholder suing them. ("Nonsense," laughter, and hear, hear.) It might be nonsense, but it might be very good law at the same time. (Hear, hear, and "oh, oh.") It often happened that the law was nonsense to those who did not understand it. (Laughter.) The directors had given this subject a very careful consideration, and they had come to the conclusion that the reserve and renewal fund was not at present large enough to warrant them deducting anything from the sums annually laid by in order that they might pay additional dividends. (Hear, hear, and cries of dissent.)

The Marquis of Tweeddale seconded the resolution.

Mr. Thomas Smith, of York, moved an amendment, "That whereas the directors have failed to carry out the wishes of the large majority of the shareholders, the report be not received, and that £50,000 instead of £75,000 be carried to the renewal account, the difference to be added to the dividends." This, he said, was nearly the same amendment as he moved last year, and which he was induced by the Marquis of Tweeddale, who then presided, to withdraw, on the full assurance by him that, if he did so, and put it in another shape after the report was passed, and the majority were in favour of it, it should be carried out. He had no doubt the noble Marquis would keep his word, and withdrew the amendment, afterwards submitting it in another form, when it was carried by a large majority. They knew the result: since then they had had another Pharaoh to rule over them, and he had done the opposite of what the noble Marquis had promised. ("No, no," and "Yes, yes.") The chairman was a director of an opposition company, and his interests were not those of the shareholders; in fact, they were against them. ("Only in your opinion.") His Lordship held £1,200 of ordinary stock, the market value of which was only £370 or £380; he received as director's fees more every year than the amount he held in stock, and therefore what did it matter to him what dividends were paid so long as he got his fees? The Marquis of Tweeddale held £2,000 of stock, and that to him was nothing; what did he care about dividends? The Hon. Mr. Cunard, whom they were asked to re-elect, held £2,000 of stock. Talk about the shareholders' interests and the directors' feeling for them—they did not care a rap! ("Hear, hear," "Order," and hisses.) Since 1880 they had paid the Telegraph Construction and Maintenance Company £6,000. They were largely interested in the Construction Company. They did not care for the shareholders; their interests were not identical. He hoped the directors would see the reasonableness of the amendment and accept it.

Mr. Baker seconded the amendment.

The Chairman said he did not wish to interrupt discussion, but the form of the amendment was such that he could not put it consistently with the articles of association. ("Oh! oh!" and uproar.) Article 164 provided that before declaring the nett profits the directors should set apart such sum or sums as in their judgment might be necessary to meet any claims or contingent liabilities against the company or to carry out new works, so that the duty of setting by the reserve fund and the determination of the amount devolved entirely upon the directors. Another article provided that no larger dividend should be declared than was recommended by the directors. It was perfectly plain, therefore, that the amendment could not be put until those two articles of association were repealed. He did not like to take any step that might appear arbitrary, but he must decline to put it to the meeting. (Uproar.)

Mr. Smith said he would alter his amendment to read "That the report be not adopted."

The Chairman: That is not an amendment. It is a simple negative.

Mr. Prust said he had sent notice to the secretary of the following resolution, which he intended to move: "That no more capital shall be taken from the reserve fund or the renewal fund for the purpose of laying new cables unless sanctioned by the shareholders in general meeting assembled." (Cheers.) He did not wish in any way to interfere with the position of the directors. He was not a "speculative holder"—(cheers and laughter)—and he had suffered for many years from a sense of duty towards their own position; but he thought the time had now arrived when they should ask themselves whether they had not got sufficient money put aside. (Cheers.) He did not wish to take anything from the reserve or from the interest on that reserve, but he maintained that quite enough money had been taken from the pockets of the deferred holders. (Applause.) He trusted the directors would do the shareholders the honour of consulting them before they took any more of their hard-earned money to put at the bottom of the sea. (Cheers and laughter.)

Mr. Blumenthal, in seconding the resolution, said it seemed to him that the articles of association were all on one side. (Applause.) The shareholders apparently could do nothing, and it was the duty of the chairman to call a meeting to take the sense of the shareholders as to whether the articles should not be amended. (Hear, hear.) The articles were ridiculous, and they should give way to common sense. (Applause.) If the chairman continued to consult the articles instead of common sense, he (the speaker) should feel bound to propose, not a vote of thanks to him, but a vote of censure, and to express his opinion that the sooner he retired into private life the better he should like him. (Laughter and applause.)

Mr. Jackson asked what prospect there was of recovering the cables that had broken down, and remarked that the directors must know that there was no need to strengthen the renewal fund, considering its present position.

Mr. Chester said the resolution proposed by Mr. Prust was a most important one. The directors were, with one or two exceptions, very small shareholders in this company, and large shareholders in the Telegraph Construction and Maintenance Company, consequently they were not dealing with their own money. As he understood it, the directors had power, according to the articles of association, to tell the shareholders at the next meeting, "Since we last met, gentlemen, a new cable has been laid by the Telegraph Construction and Maintenance Company," and that £700,000 or more had been paid for it. (Hear, hear, and a voice, "Ridiculous.") Morally and equitably this power of the directors was a wrong power—(applause)—and he asked the directors whether it was not their duty to promise the shareholders that they would call them together before they exercised it.

Mr. Abbott did not think anyone could object to Mr. Prust's resolution, and he thought the directors would exercise a wise policy if they accepted it. He had attended the meetings of this company year after year, and every year the shareholders came before the board with a suggestion which they believed to be in their own interest, and every year they were told that they knew nothing whatever about it, and that it must be left to the board. The opinion of a man like Mr. Jackson ought to have weight, but if the shareholders' opinions were of no consequence at all, the directors might as well call a meeting of the board and dispense with the shareholders altogether. The time had arrived when something must be done for the shareholders—(applause)—and there were various ways of doing it without interfering with the prerogatives of the directors. He saw a formidable array of proxies on the table and knew that Mr. Burt was in the habit of hurling the articles of association at the shareholders meeting after meeting, but he was not going to be deterred by any such manifestation of force from maintaining that shareholders had rights in the companies in which they embarked their money. At the present moment the whole £7,000,000 of Anglo-American stock was was selling at £2,200,000. Deduct the reserve fund and they had £1,450,000 as the representative value of their four cables, their goodwill, and all the rights they had acquired. Now he thought the directors might accept Mr. Prust's resolution, and promise the shareholders that they would take into consideration a scheme they might propose for the reconstruction of the capital of the company, and for the expunging of some unsatisfactory clauses from the articles of association, which were such a bone of contention. With regard to the resolution, he thought it would be madness to lay any more cables. There were too many already. Still, he thought it was a very fortunate circumstance that the cables were laid by the Construction Company, for they were the only ones working, so that so far from the alliance being to their disadvantage, it was just the other way. He (Mr. Abbott) had determined to propose a resolution with reference to the board. He entertained an opinion that the board must be composed of gentlemen whose reputation could not be approached.

The Chairman called Mr. Abbott to order, and reminded him that there was a resolution already before the meeting.

Mr. Abbott: Well, gentlemen, I shall move the resolution afterwards, because it is of the most vital importance.

Mr. Seeley, Mr. Weaver, and Mr. Trower having spoken,

Mr. Newton said it had been stated that it was absolutely necessary that the interest on the reserve fund should be added to the renewal fund. Was that provided for in the articles of association? If not, he contended that the revenue from the reserve fund was revenue, notwithstanding that it came in the form of interest. He intended to raise the point at all meetings of companies with which he was connected, and to urge that the interest on the reserve should be considered as part of the revenue, so that when £75,000 was put to the reserve they should not have the idea that it was only £50,000.

The Marquis of Tweeddale rose to make a personal explanation and read an extract from his speech twelve months ago to show that the statement of Mr. Smith was absolutely unfounded.

The Chairman replying to the questions and comments, said he was inclined to make every allowance for the feelings of shareholders, and particularly of deferred shareholders, who came there and found that they were with little or no dividends, and he would not refer at all to the angry, he might almost say offensive, expressions used with regard to the board of directors. There was one observation he would make, however. It had been most explicitly asserted that the board sacrificed the interests of this company to those of the Telegraph Construction Company, and that was based on the statement that the directors were largely interested in the Construction Company. The exact fact was this, that not a single director, so far as he knew, was interested, directly or indirectly, in that company, except Sir Daniel Gooch. Sir Daniel was one of the founders of this (the Anglo-American) Company, he had stuck to it through good report and evil report, and he was now a holder of £35,000 of stock. The question raised by Mr. Newton seemed to be a very reasonable one to discuss—whether the interest accruing from the reserve fund should be added annually to the reserve fund or be treated as ordinary income and distributed amongst the shareholders. *Prima facie* he thought the proceeds of the reserve fund ought to belong to that fund, but under the circumstances, whether it could not be diverted might be considered, and he would take care that it should be. (Applause.) Mr. Smith in proposing his resolution alluded to the resolution which was carried this time last year, but he entirely forgot to allude to the proceedings of a subsequent meeting. It had been said that if it had not been backed by the proxies of the Globe Company and the Submarine Trust and so on, the board would have been beaten. He would remind that gentleman that those proxies were not used at all; the board won by the votes in the room, and the resolution passed at the previous meeting was rescinded. The articles of association had been criticised. Shareholders came into the company knowing very well what the articles of association were, and it was rather unreasonable to accuse the board of hurling the articles of association at their heads. What could a board do? The only direction they could have was from the articles of association. The articles of association, however, might be altered. If they were to take this course and change their provisions the directors would bow to their decision, and if they considered that the change they made was such that they could not satisfactorily manage the business under the new articles, they would retire for other people to be appointed. But the change must be made by the whole body of the shareholders. It was obviously absurd to talk of those present representing the whole body of the shareholders, who numbered 5,000. And as long as the articles were unchanged, he would be forfeiting his claim to their confidence if he allowed them to be infringed. Mr. Prust's proposition was, no doubt, a very sound and proper one; but it was diametrically opposed to the rules under which their business was conducted, and those rules must be changed before it could be carried out. Mr. Jackson had asked if there was any prospect of their competitors' broken cables being repaired. This was a very unfortunate time of the year to have to go into the Atlantic to repair cables, and there might be some delay, but that they would be repaired he entertained no doubt whatever. The payment for traffic during the period the cables were out of repair was regulated by the provisions of the contract between the parties; if the cables were not repaired within twelve months, the payment on behalf of the defaulting cable diminished. Considerable time was allowed for the repair to be effected, and they must see that this was as much in their interests as those of the other companies, for it was just as possible that their cables might break. An amalgamation of the various companies with one board had been suggested by a shareholder. This would, of course, lead to a certain economy, but their experience of amalgamation had not been very favourable, and he knew that on the part of their confederates there was a very strong objection to it. It was made an essential condition of the union for the purposes of a joint purse that the companies should be kept as distinct organisations, not with a view to the interests of the directors, but to the management of the traffic and the possibility of future competition. However, the question was a perfectly legitimate one to discuss, and they might bring it forward in any way they pleased.

The resolution for the adoption of the report was then put and carried by 55 votes to 21.

Mr. Prust's resolution was, after some discussion, put as a recommendation, and carried by 44 votes to 41.

The Chairman moved the re-election of Sir James Anderson as a director, which was seconded and carried. The re-election of Mr. W. S. Cunard, however, when proposed, was lost by 48 votes to 23. A poll was demanded.

Mr. Abbott now rose to move his resolution. He said he had given notice of it to the secretary, and it was as follows:—"That in the opinion of this meeting it is not in the interest of the Anglo-American Telegraph Company that it should be represented in America by Mr. Cyrus W. Field, and that he be requested to resign in order that a gentleman not identified with competitive schemes may be appointed in his stead." (Applause.) He sent with that notice a request that a copy of it might be sent to each shareholder with the report, and in reply to that request he got the following:—"Your letter was laid before the directors, and I am instructed to inform you that they are not prepared to issue to the proprietors the resolution you have submitted, as it does not appear to them that the interest of the company would be promoted thereby." (Laughter and Oh, oh!) When a shareholder wished to get the independent opinion of his fellow shareholders, he was frustrated in that way. He had good reasons for considering it unsatisfactory to retain Mr. Cyrus Field on the board. (Applause, and cries of "Go on.") They knew him well, and so did his fellow citizens. (Cheers and laughter.) Those who read the American papers would see that Mr. Field was held in low esteem by the people with whom he came in contact. He neither added ornament to the board nor did his name adorn the report. (Applause.) As he entered this meeting, he was served with a letter by Mr. Burt, the solicitor to the company. He had thought that England was a free country. (Laughter, and a voice: "It isn't though.") But it seemed that a man's mouth was to be stopped because he desired to call into question some transactions of one of the directors. If the chairman of this company, or any of his colleagues, had been mixed up with the transactions of Mr. Field in connection with the floating of the Wabash scheme—(hear, hear, groans and hisses)—upon this market they would have been hurled from office without one single question. (Applause.) The letter which he (Mr. Abbott) had received from Mr. Burt began as follows:—"We are desired by Mr. Cyrus Field to protect his interest with respect to a telegraphic message which appeared in the New York *Herald* yesterday, and of which we annex a copy." What had he (Mr. Abbott) to do with the New York *Herald?* (Hear, hear, and applause.) The letter went on: "We beg to enquire whether the message was sent with your authority or knowledge, and, if so, what justification you have for such a gross charge against him? We beg to warn you"—that was Mr. Burt, the solicitor of this company, warned him (laughter)—"that Mr. Field will take all measures open to him to vindicate his character and reputation, and to punish the author of such a scandalous libel."

At the request of Mr. Burt, Mr. Abbott read the telegram, which was as follows:—"Mr. William Abbott, broker and stock operator, supported by many stockholders of the Anglo-American Telegraph Company, announces that at Friday's meeting of shareholders he will introduce a resolution to expel Mr. Cyrus Field from the directorship on the ground that he is unworthy of any position of confidence or trust." (Applause, and cries of "Quite right.") Mr. Abbott proceeded to remark that his resolution was a very mild one—one that any shareholder had a right to put on record, and if the *New York Herald* chose to print a libel, that was nothing to do with him. (Hear, hear.) Why did not Mr. Field attack the *Herald?* Because Mr. Field was too well known in New York, and the *Herald* had been "going for him" lately. (Applause.) Well, he intended to propose this resolution whether it were in accord with the articles of association or not.

Mr. Prust seconded the resolution.

The Chairman appealed to the meeting to see fair play, and not allow a man to be prejudiced by a resolution passed behind his back, without a tittle of evidence being given to justify it, and to drive from the company by a resolution of the shareholders in that room the man to whom more than to any other the existence of the company was due. (Hear, hear, and hisses.)

Mr. Mormon moved as an amendment:—"That Mr. Field have an opportunity of answering the charges made against him."

Mr. Edwards seconded, and after a heated discussion it was put to the meeting, with the result that it was lost, and Mr. Abbott's resolution carried by 39 to 33.

A poll was demanded to be taken at the termination of that meeting, which was then adjourned for the purpose.

The adjourned meeting was held at the offices of the company, 26, Old Broad Street, on Saturday. The result of the poll was announced as follows:—In favour of Mr. Cunard and Mr. Field £2,576,795 stock; 34,877 votes; 1,068 voters. Against £10,756 stock; 165 votes; 3 voters. Majority in favour £2,566,039 stock; 34,712 votes; 1,065 voters.

The Chairman then declared that Mr. W. S. Cunard was re-elected a director of the company, and that the resolution proposed by Mr. W. Abbott as to Mr. Cyrus Field was lost.

The Maxim-Weston Electric Company, Limited.

THE directors of this company submit a balance-sheet for nine months, including 1st April and 31st December, 1884, having decided to close the financial year of the company hereafter at the end of each year, as customary, which, by dividing the "Lighting Season," will enable the directors in future to declare an interim dividend.

The directors have pleasure in stating that their operations during the nine months have resulted in a profit of £4,975 13s. 2½d. after deducting all expenses.

The sum to the debit of profit and loss account to March 31st, 1884, including further charges to that date as shown in the account (after crediting the reduction of capital), amounts to £2,544 14s. 7d., which the directors are advised must be met before any dividend is paid, and this absorbs more than one-half of the net profits made during the nine months, and reduces such profits to £2,430 18s. 7½d.

The directors recommend a dividend out of this sum at the rate of 5 per cent. per annum for the last four months, and propose to transfer the balance, viz., £764 5s. 3½d. to the credit of a reserve account.

The directors consider that the present balance sheet justifies their opinion that the capital of the company is not out of proportion to its dividend-earning capacity, which is steadily and satisfactorily increasing, notwithstanding the existing depression in nearly every branch of commerce.

The directors think that it is almost unnecessary to remind shareholders that this result has been brought about in 21 months with a stock nearly all in an unmerchantable condition when taken over by the present board, and a balance of new cash capital of about £2,500 (after liquidating the debts incurred under contracts by the late board), and that the management have had to compete with companies possessing ample capital besides large stocks of all necessary appliances.

A reference to the profit and loss account will show that a considerable increase has taken place in both the manufacturing and installation works of the company, and that great reductions have been effected in the costs of staff, offices, works, &c.

The largest item in balance sheet, viz., patents, &c., has not been augmented beyond a small sum paid for new patents, although patents recently acquired from the American company are of considerable value.

The value of the patents held by the company has been further increased by a new dynamo and several electrical appliances of considerable merit just completed by our own staff, and specially adapted for a branch of lighting where the dangers consequent on fire render the electric light particularly suitable.

The directors intend during the ensuing year vigorously to prosecute an extension of the company's business in directions now opening up, and also to meet the requirements for installations where special conditions call for special appliances, and are giving their attention to such alterations in the available plant of the company as will render equally satisfactory results, but for obvious reasons refrain from doing more than foreshadowing the same, so as to show that the directors are fully alive to the interests of the shareholders, and will take care that the company are so situate as to be well in the van of progress.

Stock has been valued in detail by the managing director and the works manager, and is all in perfect condition, a large portion having been purchased during the last few months.

The directors report that the credit of the company is excellent, and that they have now several months' work on hand. All installations to date have given satisfaction, and the directors believe, from promises made after estimates applied for had been furnished, that as soon as an improvement in trade takes place a large increase of orders will follow from these and other sources.

British Insulite Company, Limited.

The annual general meeting of this company was held on Tuesday, at the City Terminus Hotel.

The Right Hon. E. P. Bouverie presided, and in moving the adoption of the report and accounts observed that it was not satisfactory to directors to have to present accounts showing a considerable loss. Looking at the question in its main features, he felt convinced that the loss of so much money by the company was owing to the complete failure at present of any effort for general electric lighting. This fact he attributed to the Electric Lighting Act of 1882, which had crushed out every attempt to promote the new light. The public were always very jealous of monopolies, but they were not perhaps aware of the advantages they had derived from having given monopolies in former times to companies when they were embarking in any great enterprise. It was the very fact of a fresh outlet for capital, promising new and excessive returns, which induced people to go into the undertaking, but if the authorities stepped in, and in advance laid hands on any excessive profits being made by those who ventured in the new undertaking, they altogether stopped the work from being carried out. He afterwards read extracts from letters showing that where the insulating material had been used it had given unequivocal satisfaction. It was, however, found in the present state of the demand for the material that it was impossible to keep the works going on at a profit, and to bear the cost of establishment, manufactory, office, and other expenses. The directors had come to the conclusion that it would be for the advantage of the shareholders to put the company into liquidation. After dealing with certain items in the accounts, he expressed his belief that there were sufficient assets to pay all the costs of the liquidation with what they had in hand and certain arrears of call, and possibly to leave something to return to the shareholders. At the worst they did not expect that a further call would have to be made.

The motion was seconded and carried unanimously, after the chairman had replied to a few questions.

An extraordidary general meeting was held subsequently, when a resolution was passed for the voluntary winding-up of the company, and the appointment of Mr. S. L. Price, of Gresham Street, as liquidator.

The National Company for the Distribution of Electricity by Secondary Generators, Limited.

The Secretary of this company has favoured us with the following report of the proceedings at a meeting held on Monday last:—

The second ordinary general meeting of the National Company for the Distribution of Electricity by Secondary Generators, Limited, was held at the offices of the company, 18, Warwick Street, Regent Street, on the 9th inst.

The report of the directors explained the expenditure that had been made on the Metropolitan and Turin-Lanzo Railways over circuits respectively of 15 and 50 miles which, though yielding no profit, had proved the system.

The directors announced the commencement of a large installation by a company formed by Sir Coutts Lindsay for the house-to-house distribution of light in Bond Street and the neighbourhood by means of the system of secondary generators.

Under a temporary arrangement part of the Grosvenor Gallery and some neighbouring shops are already lighted by this system.

The installation at Turin, which obtained the first prize of £400 and a gold medal at the International Electrical Exhibition, has led to important and valuable business. It was also stated in the report that the company is now prepared to transmit and distribute mechanical power by means of their secondary generators.

Looking to the business in hand and that in prospect, the chairman anticipated that the coming year would yield profitable results to the company.

The meeting closed with the usual votes.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—Subject to audit, this company's accounts for the past year show a profit of £106,870, including £37,900 brought forward from 1883. The directors have resolved to add £20,000 to the reserve fund, and to recommend a dividend of 10 per cent. (making 15 per cent. for the past year), carrying forward £40,070.

The Telegraph Construction and Maintenance Company, Limited.—The directors notify that subject to the final audit of the accounts they propose paying a dividend of 15 per cent. (£1 16s. per share), in addition to the ad-interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1884, free of income-tax.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—An interim dividend at the rate of 7 per cent. per annum for the half-year ended 31st December, 1884, is payable on the 11th instant to shareholders registered in the books on the 4th instant.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st January, are £2,684, as compared with £2.865 in the corresponding period of 1884. The October receipts, estimated at £4,147, realised £4,231.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 6th were £2,823, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

CORRESPONDENCE.

The Drawbaugh Telephone Case.

"Washington, Dec. 30, 1884.—The effect of the decision of the Supreme Court in the Hoe patent case (where it was held that an appeal did not lie from the Commissioner of Patents to the Secretary of the Interior) upon similar cases passed upon by the Secretary, is now being tested in a motion pending before the Commissioner of Patents. In February last the Secretary reversed the decision of the Commissioner in the patent telephone interference case of Blake *v.* Drawbaugh *v.* Edison and restored Edison to his position in interference, from which he had been displaced by the Commissioner. Drawbaugh's counsel now assert that the Secretary's decision in the case was nullified by the decision of the Court, and that Edison is barred from the interference proceedings. Mr. Roscoe Conkling, representing Edison, to-day made argument before the Commissioner, taking the ground that the Secretary was *de facto* judge at the time, and that sound practice required the Commissioner to support the decision."

As bearing on the above I send you extracts from the Patent Laws of the United States:—

"Sec. 4909. Every applicant for a patent, any of the claims of which have been twice rejected, may appeal from the decision of the primary Examiner, or of the Examiner in charge of interferences in such cases, to the board of Examiners-in-Chief.

"Sec. 4910. If such party is dissatisfied with the decision of the Examiners-in-Chief, he may appeal to the Commissioners of Patents in person.

"Sec. 4911. If such party, *except a party to an interference*, is dissatisfied with the decision of the Commissioner of Patents, he may appeal to the Supreme Court of the District of Columbia sitting in banc."

The italics in sec. 4911 are mine. It appears that there is no appeal from the decision of the Commissioner, and that Drawbaugh is likely to gain his priority over Edison.

W. C. B.

February 2nd, 1885.

Definition of the word "Tympan," and description of a Tympan by an eminent Scientist.

I opine that the scientific world will be pleased to have the definition of the word "tympan" and a description of a tympan from a no less distinguished personage than Sir William Thomson, a Professor of Natural Philosophy in the University of Glasgow and a Fellow of the Royal Society.

During the trial of the action for infringement brought by the United Telephone Company *v.* Harrison-Cox-Walker, before Mr. Justice Fry, in 1882, Sir William Thomson was examined as an expert witness on the part of the United Telephone Company, and as I desire to be exact to the letter, I shall transcribe accurately a few questions put to him and his answers thereto, giving the number of the questions as I find them in the report of the case printed from the notes of the shorthand reporters.

Q. 1272. Take the case of a drumhead—that is strained parchment, is it not?

A. (By Sir William)—Yes.

Q. 1273. And in that condition it will pick up vibrations of all kinds—it has no special preference power?

A. Its fundamental node is so grave, and the different nodes of fundamental vibrations corresponding most nearly to the sound that it is called on to pick up are so close and so near the same period, that it can pick up one thing as well as another.

Q. 1274. A tympanum is something strained which picks up all sorts of vibration?

A. (By Sir William)—Yes.

Q. 1298. In picking up those vibrations does it matter whether the plate that is to pick them up is circular or oblong, or any other shape?

A. (By Sir William) — Certainly, it makes a great difference.

This testimony was given by Sir William in his cross-examination in regard to the iron tympan in Bell's receiver.

I will now transcribe a few questions and answers when Sir William was cross-examined upon the Edison transmitter.

Q. 1775. By a tympan you mean something which will, as you explained to us before, vibrate after the fashion of a drum?

A. (By Sir William)—Yes.

Q. 1776. Edison always has that tympan?

A. (By Sir William)—Yes.

Q. 1777. In all the apparatus that he describes in his specification he has it, has he not?

A. (By Sir William)—I think so.

Having given above the *definition* of a "tympan" by Sir William, I shall now transcribe a few questions and answers which will furnish a *description* of a tympan given by Sir William.

Q. 1842. You see two plates of brass (lying on a board) which are connected to two different poles of the battery?

A. (By Sir William)—Yes.

Q. 1843. They are some little distance apart, and over the gap is a heap of coke carbon?

A. (By Sir William)—Yes.

Q. 1851. (By Mr. Justice Fry) You say this might speak although it has no tympanum?

A. (By Sir William)—It has a tympan, my Lord.

Q. 1852. Where is the tympan?

A. (By Sir William)—The tympan is that large surface you are looking at, the top surface of the wood and brass.

Your readers have now before them the scientific *definition* of a tympan, and in case they should not understand fully the *definition*, I refer them to the above *description* of a tympan by Sir William Thomson who, Lord McLaren said, was "the most eminent electrician in the United Kingdom."

Although I ought to bow with great deference before the judgment of so eminent an electrician, I must confess that my stupidity prevents me from seeing in the description of a tympan by Sir William, anything like a tympan, or anything that will vibrate after the fashion of a drum.

W. C. Barney.

February 10th, 1885.

The Morgan Brown (Bell) Patent—Absurd Claim of United Telephone Company—Intermittent Current in Telephony.

Your correspondent, "F. T. H.," suggests that this patent is bad because the provisional specification "neither shows, mentions, or describes a soft iron pole piece for the magnet, and yet it is claimed as an essential and specific part of the combination claimed by claim 8," and he asks for the opinion of your readers having a knowledge of the patent law. Though I wear neither "*silk*" nor "*worsted*," I offer him my opinion for what it is worth, and I cite decisions which will, I think, sustain my proposition. The law, I think, has been clearly and well settled thus:—A provisional specification does not require to specify the invention; it only requires in a reasonable sense to identify the invention. The very object in allowing nine months between the provisional and the final specifications is to allow the inventor to perfect it; the law requires that he should, in general terms, state what his invention is, but does not require details. On that matter I give one or two references, which sustain my proposition. In Newell *v.* Elliott (Higgin's Patent Digest, page 162), Chief Baron Pollock says:—"The object of the statute, which requires a provisional specification, is nothing more than a legislative recognition of the custom which called upon every patentee, when he applies for a patent, to give some notion what his invention is; the object is to ascertain the identity of the invention, and to make it certain that the patentee shall ultimately obtain his patent for that invention which he presented to the Attorney General in the first instance." In Penn *v.* Bibby (Higgins, 360), "The filing of the provisional specification protects the invention for six months. The object of this protection evidently is to enable the patentee to perfect his invention by experiments, so that he may be in a condition to describe in his complete specification, as the result of his experience, the best manner of preparing the invention," so that it is quite plain that it is enough if the information which the inventor has given in his provisional specification shall be such as that he will not be able to perpetrate a fraud on the law officers by claiming in his final specification an invention other than that named in the provisional specification.

The House of Lords (3 Law Reports, House of Lords' Appeal Cases, page 1,074), Lord Blackburn said, "That what is required to be done in the provisional specification is to state the nature of the invention, but minute description is not necessary."

Morgan Brown's provisional specification states very clearly the nature of his invention, and the use of a soft iron pole piece described in the final specification in lines 13, 14, and 15, page 20, 5th edition of the Patent, and claimed by the 8th claim, is the result of the inventor's experience, and is clearly within his rights.

I may here say that a magnet with soft iron pole pieces, with coil in it, is not an invention of Bell. Such a magnet was invented by Prof. Hughes, and was used by him in his telegraph printer; a drawing and description thereof can be found on page 191 of a work by the late eminent scientist, Comte du Moncel, entitled "Telegraphe Electrique," Paris, 1864. Curiously enough the drawing therein is a *fac simile* of that in fig. 31 of Bell's patent. Did Hughes take it from Bell!!

On other grounds I am of opinion that the Morgan Brown patent is bad, and one is, that a material part of it was published in England several months prior to the date of the patent. The material part I refer to is the first claim in the patent as amended, which was published, *ipsissimus verbis*, as the second claim of Bell's U. S. Patent of March 7th, 1876, in the official Gazette of the U. S. Patent Office, on view in the British Patent Office, 3rd July, 1876. The law of prior publication seems to be very clear. In Huddock *v.* Grimshaw Lord Ellenborough said :—"If prior to his obtaining a patent, any part of that which is the substance of his invention has been communicated to the public in the shape of a specification of any other patent he cannot claim the benefit of his invention ;" and in Househill Company *v.* Neilson, an appeal to the House of Lords, Lord Lyndhurst, L.C., said, "If the machine is published in a book, though it has never been worked, is not that an answer to the patent ?" and Lord Brougham added, "It negatives being the true and first inventor." This defect may, however, be cured by amendments, on application to the Patent Office at any time, even during the trial of an action for infringment.

I am strongly inclined to think that the United Telephone Company will be forced to make such an application upon the hearing of my action against them for damages caused to me by their false and injurious statement that the Boult telephone, No. 11,383, of 1884, is an infringement of their patent rights.

Another ground for my reason that the Bell patent is void is that there was published in England, in 1869, the following description of a telephone receiver:—"An electro-magnet in front of a brass diaphragm with an iron button attached to the diaphragm." This was an invention of Professor Van der Weyde, and was exhibited at a public lecture in New York in January, 1869. In the REVIEW of November 1st, 1884, page 345, will be found a drawing of the instrument, and of November 8th, 1884, will be found further particulars about this telephone, which is clearly an anticipation of Drawbaugh, McDonough and Bell's.

In regard to absurd claims set up by the United Telephone Company, I have before me affidavits of their solicitor and of two of their experts that a receiving telephone, having an iron armature in the form of a cross, the limbs $\frac{3}{8}$ of an inch broad, and curved so as to form, as it were, four legs resting loosely on the perimeter of the case containing a magnet—the centre of cross having a short space upon which is held a disc of wood, or cardboard—is an infringement of Morgan Brown's patent. To the United Telephone Company and their advisers, legal as well as scientific, I suggest that they reflect on the words : "Quem deus vult perdire priusquàm dementat."

As my experiments with intermittent and reversed intermittent currents have a bearing on the Bell system, I may as well, in this communication, give the information regarding those experiments asked for by "F. T. H."

In 1,000 words in Morse characters there are about 15,000 breaks of the continuity of the current, but when a band of paper sufficiently long to contain perforations representing that number of words in Morse characters has a line of perforations representing dots only, equal distances apart throughout its entire length, there are about 20,000 actual breaks of continuity. Such a band of perforations I use in my experiments.

In regard to the possibility to move a chemically prepared paper at a sufficient speed so that the current would mark whether the current was continuous or not I can assure "F. T. H." that in 1872 I transmitted in one minute 1,600 words in Morse characters punched in a band of paper, and the characters were recorded distinctly, without "tailing," on chemically prepared paper. This was done in my laboratory only.

In 1875, on the Belgian Government telegraph lines, a series of experiments was made by me. The following account of them was published in the *Independence Belge*, of 4th September, 1875 :—

"On s'occupe beaucoup, depuis quelques mois, d'un nouveau système de télégraphie rapide et simultanée, invente par un ingénieur Américain, M. le Major Barney, et essayé sur les lignes de l'Etat. Les resultats, des cette epoque, avaient été très satisfaisants.

"'Le 1 Juillet, la même dépêche a été transmise par un seul transmetteur de Bruxelles à Ostende et à Anvers en même temps, à une vitesse de 600 mots par minute. Ces essais ont eu lieu sur des lignes reliées à Ostende et à Anvers pour augmenter la longueur de de ces lignes, qui était, la première de 250 kilomètres, la seconde de 92 kilogrammes.

"'Le 17 Juillet, on a transmis des dépêches d'Ostende à Bruxelles, â une vitesse de 1,002 mots par minute (toute la dépêche a été lue par les employés présents).

"'Le 25 Août, de Bruxelles à Bruxelles en passant par Arlon, distance 380 kilomètres, les dèpêches ont été transmises à une vitesse de 600 mots par minute et lues par les employés du bureau.

"'Il y a lieu de féliciter l'administration des chemins de fer, postes et télégraphes, d'avoir, dans l'interêt de la science et du progrès, mis ses lignes télégraphiques à la disposition des expérimentateurs.'"

The mechanism I employed to produce the breaks in the continuity of the currents are very easily procured; a Bain or Wheatstone transmitter and receiver, constructed so as to move the paper at a speed of about 1,000 words a minute, using the centre line only of holes in the Wheatstone paper, is all that is necessary to prove the breaks ; and then putting the transmitter with the perforated paper in the circuit of battery and microphone and primary of induction coil with a receiver in the secondary circuit will establish the result I stated, or will disprove it. When the makes and breaks of the continuity of the current took place, but without speaking to the carbon microphone, a continuous light grating noise was audible in the receiver, but when conversation was carried on through the carbon microphone no sound whatever, other than the words spoken, was audible; and, as I before said, the articulation was perfect, the sentence—"Seven sisters sat sewing several seams" was rendered with marvellous accuracy.

W. C. Barney.

February 8th, 1885.

Scientific Secondary Batteries.

In his letter of last week, "Unscientific" asks a number of questions respecting Mr. Tribe's improvements in secondary batteries. He does not appear to be aware that Mr. Tribe is the joint author of a series of papers on the "Chemistry of Secondary Batteries," which appeared in the pages of your journal, and were subsequently issued in book form by Messrs. Macmillan. The experiments described in these papers will, it is hoped, induce even your correspondent to pardon Mr. Preece for his statement that the "subject was approached in a truly scientific spirit."

The novelty of the results referred to, and of the patents based upon them, consists in the way in which local action is studied and grappled with, and if "Unscientific" has but an elementary knowledge of the chemical actions which go on in secondary batteries, he must know that local action has been the most potent agent in reducing these structures to a crumbling mass.

With regard to working value, your correspondent may rest happy in the belief that any statement made by Mr. Preece on this score was based on trials by himself of Mr. Tribe's battery.

"Unscientific" would appear to be anxious to avail himself of the improvements, which it may be supposed he could do were he to follow the usual course.

I cannot answer further any question by "Unscientific," or other anonymous writers.

Alfred Tribe.

Dulwich College, S.E.,
February 10th, 1885.

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Row, E.C.—February 14, 1885.